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Kawaguchi et al.

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(54) **RADIO ACCESS SYSTEM, CONTROLLING APPARATUS, AND TERMINAL APPARATUS**

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(30) **Foreign Application Priority Data**

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H04W 24/00 (2009.01)
H04W 4/02 (2009.01)
H04W 4/08 (2009.01)

(52) **U.S. Cl.**
CPC . ***H04W 4/02*** (2013.01); ***H04W 4/08*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

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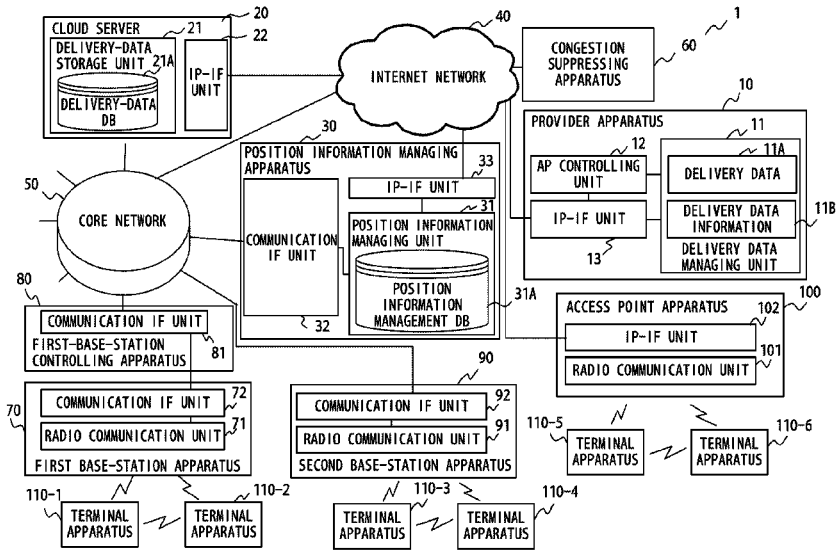
Primary Examiner — Adolf Dsouza
(74) *Attorney, Agent, or Firm* — Fujitsu Patent Center

(57) **ABSTRACT**

A radio access system includes a controlling apparatus that when the terminal apparatuses to which delivery data is to be delivered are concentrated in a particular area, groups the terminal apparatuses as a terminal apparatus group, selects a representative server terminal apparatus from the terminal apparatuses, creates data map information indicating a delivery rule for delivering the delivery data from the representative server terminal apparatus to another terminal apparatus, adds information for identification of the representative server terminal apparatus to the data map information, transmits the group information and the data map information to the terminal apparatuses, and instructs a delivery data server to deliver the delivery data to the representative server terminal apparatus; and a terminal apparatus that obtains the delivery data by communicating, in accordance with the received data map information, with the another terminal apparatus within the terminal apparatus group included in the received group information.

9 Claims, 16 Drawing Sheets



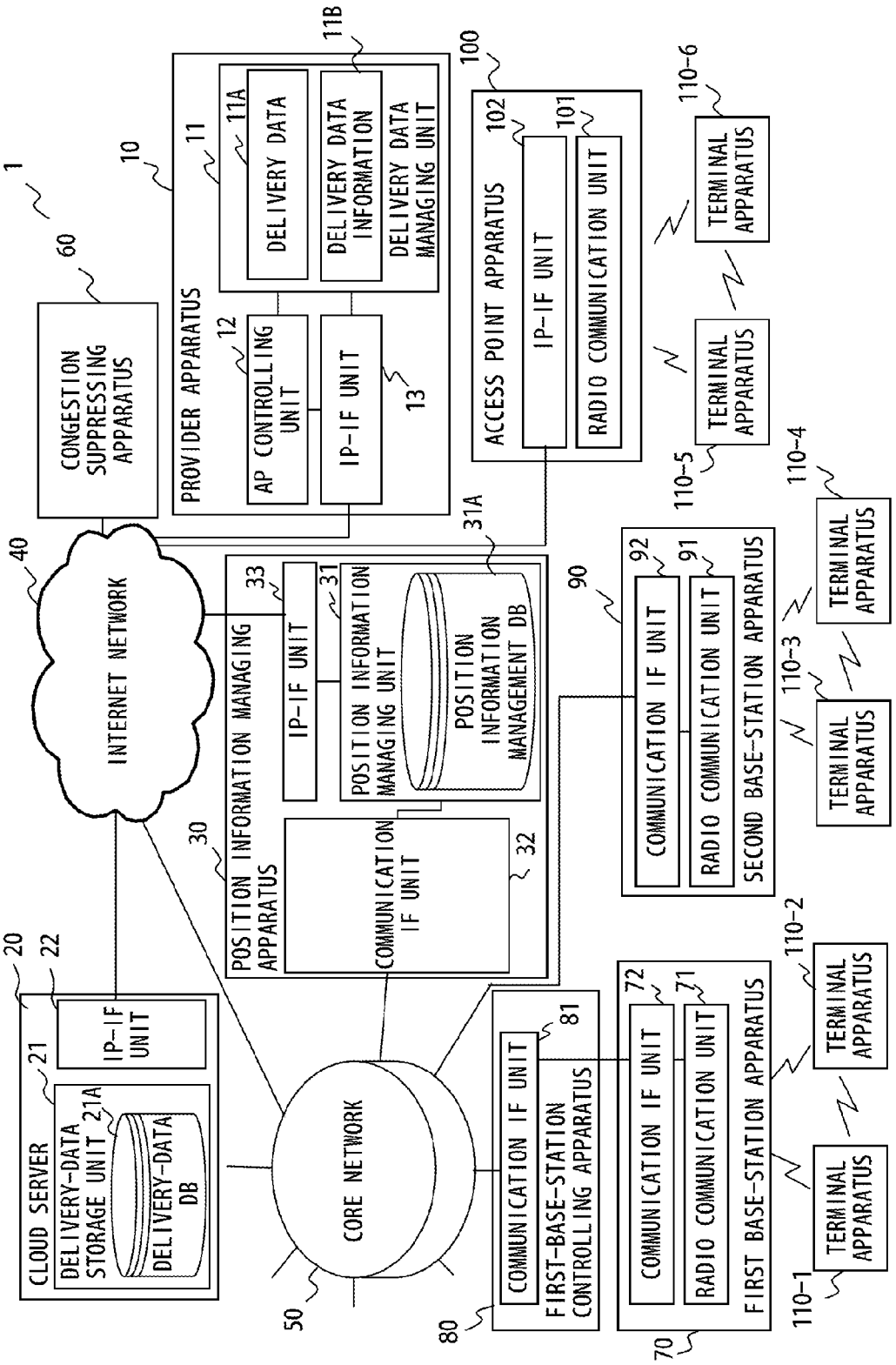

1
10
11
11A
DELIVERY DATA
11B
DELIVERY DATA INFORMATION
DELIVERY DATA MANAGING UNIT
PROVIDER APPARATUS
12
AP CONTROLLING UNIT
13
IP-IF UNIT
60
CONGESTION SUPPRESSING APPARATUS
100
ACCESS POINT APPARATUS
102
IP-IF UNIT
101
RADIO COMMUNICATION UNIT
110-6
TERMINAL APPARATUS
110-5
TERMINAL APPARATUS
110-4
TERMINAL APPARATUS
110-3
TERMINAL APPARATUS
110-2
TERMINAL APPARATUS
110-1
TERMINAL APPARATUS
40
INTERNET NETWORK
31A
POSITION INFORMATION MANAGEMENT DB
33
IP-IF UNIT
31
POSITION INFORMATION MANAGING UNIT
30
POSITION INFORMATION MANAGING APPARATUS
COMMUNICATION IF UNIT
32
90
92
COMMUNICATION IF UNIT
91
RADIO COMMUNICATION UNIT
SECOND BASE-STATION APPARATUS
20
22
IP-IF UNIT
21
CLOUD SERVER
DELIVERY-DATA STORAGE UNIT
21A
DELIVERY-DATA DB
CORE NETWORK
50
80
81
COMMUNICATION IF UNIT
FIRST-BASE-STATION CONTROLLING APPARATUS
72
COMMUNICATION IF UNIT
71
RADIO COMMUNICATION UNIT
FIRST BASE-STATION APPARATUS
70

FIG. 1

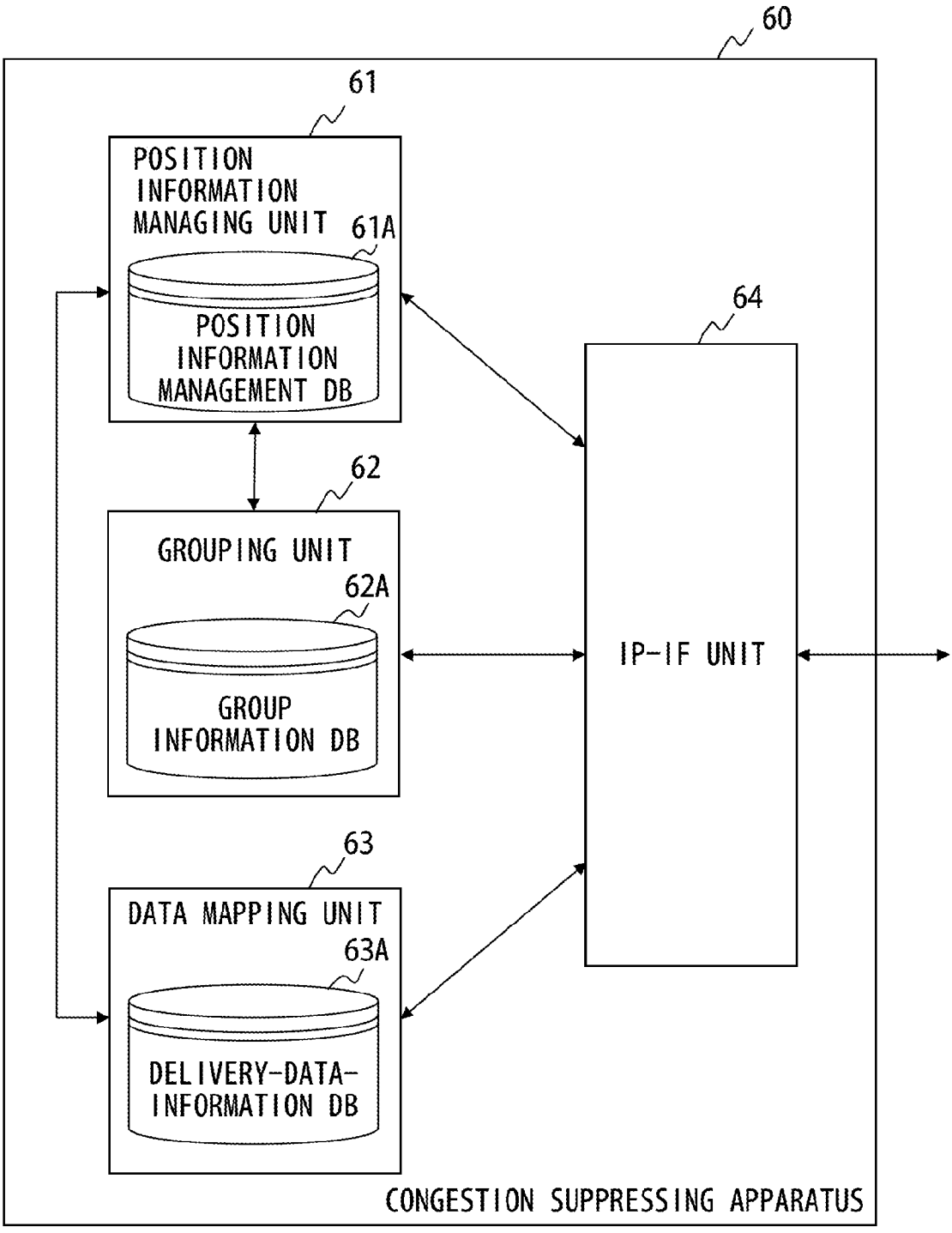

60
61
POSITION INFORMATION MANAGING UNIT
61A
POSITION INFORMATION MANAGEMENT DB
64
62
GROUPING UNIT
62A
GROUP INFORMATION DB
IP-IF UNIT
63
DATA MAPPING UNIT
63A
DELIVERY-DATA-INFORMATION DB
CONGESTION SUPPRESSING APPARATUS

FIG. 2

AREA NUMBER	TOTAL NUMBER OF TERMINALS	GROUP ID	TERMINAL APPARATUS NUMBER (MAXIMUM: 65535)
1	100	1	0x0001～0x0064
2	200	2	0x0001～0x00C8
3	500	3	0x0001～0x01F4
4	1000	4	0x0001～0x03E8
5	5000	5	0x0001～0x1388
6	10000	6	0x0001～0x2710

FIG. 3

		X ADDRESS																												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Y ADDRESS	1	1	5	9	13	17	21	25	29	33	37	41	45	49	53	57	61	65	69	73	77	81	85	89	93	97	101	105	109	113	117
	2	2	6	10	14	18	22	26	30	34	38	42	46	50	54	58	62	66	70	74	78	82	86	90	94	98	102	106	110	114	118
	3	3	7	11	15	19	23	27	31	35	39	43	47	51	55	59	63	67	71	75	79	83	87	91	95	99	103	107	111	115	119
	4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120

FIG. 4

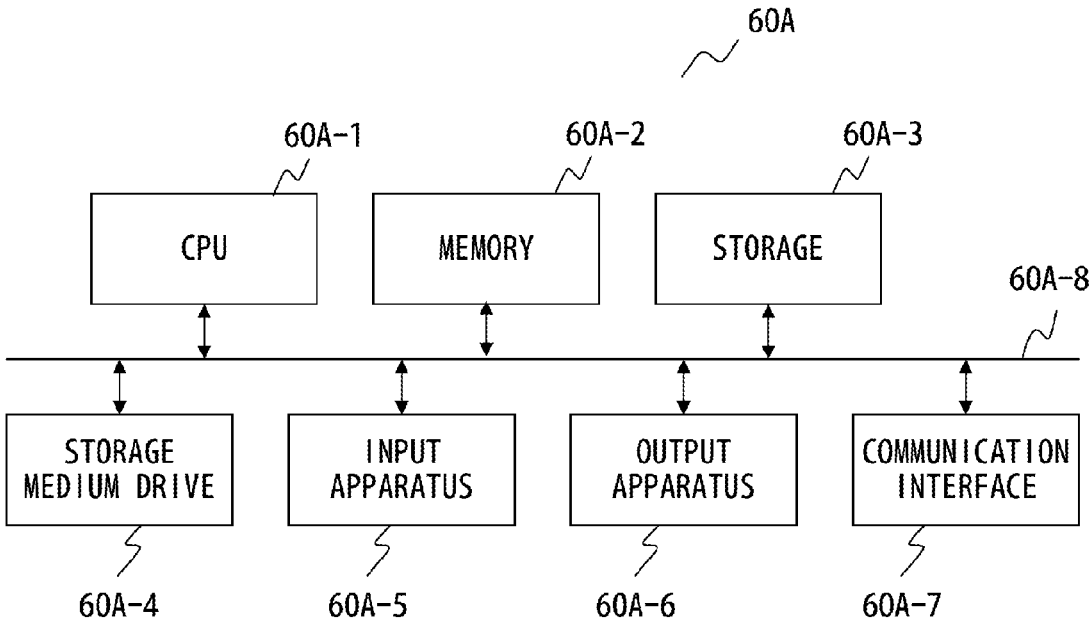

60A
60A-1
60A-2
60A-3
CPU
MEMORY
STORAGE
60A-8
STORAGE MEDIUM DRIVE
INPUT APPARATUS
OUTPUT APPARATUS
COMMUNICATION INTERFACE
60A-4
60A-5
60A-6
60A-7

FIG. 5

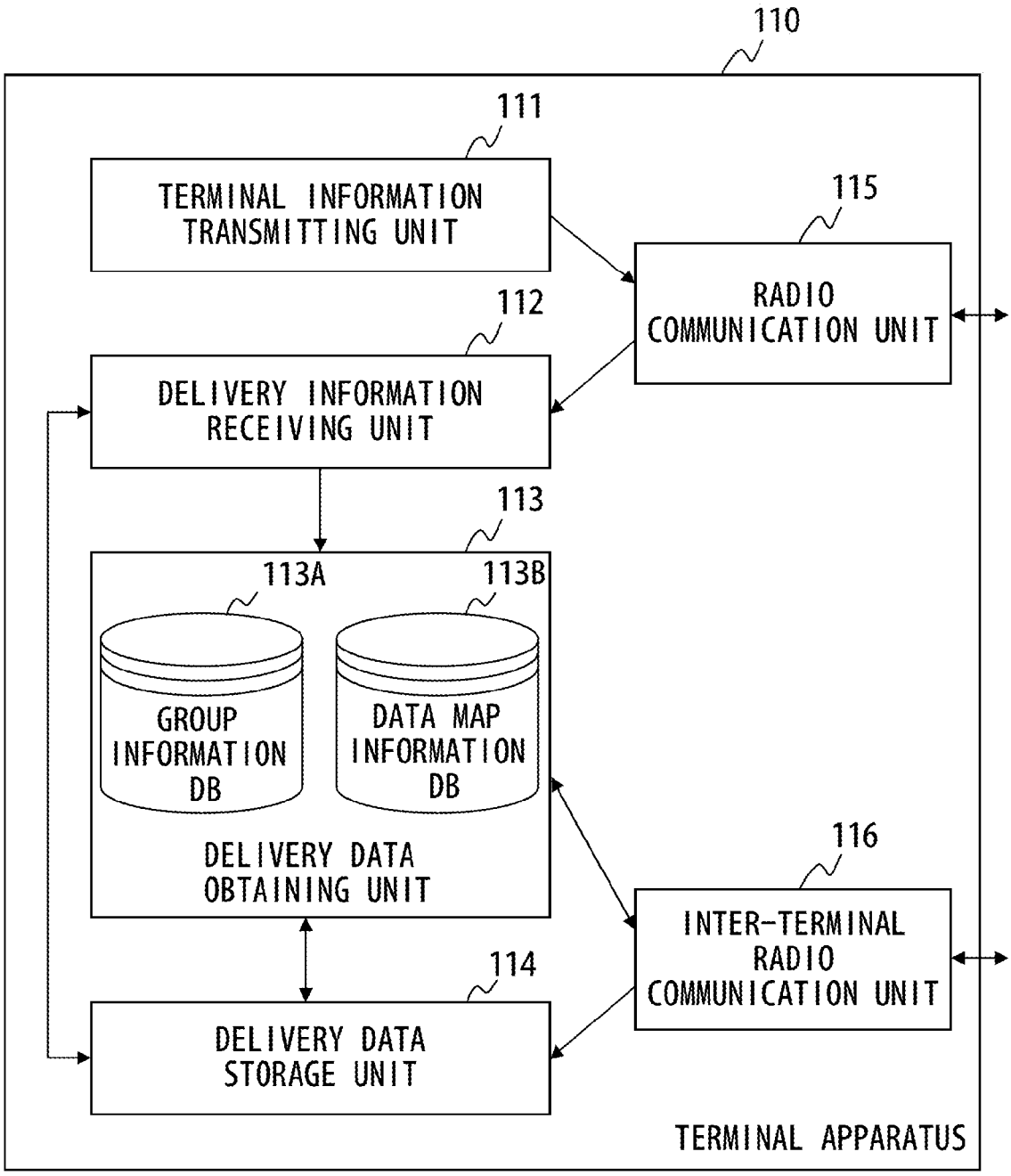

110
111
TERMINAL INFORMATION TRANSMITTING UNIT
115
RADIO COMMUNICATION UNIT
112
DELIVERY INFORMATION RECEIVING UNIT
113
113A
113B
GROUP INFORMATION DB
DATA MAP INFORMATION DB
DELIVERY DATA OBTAINING UNIT
116
INTER-TERMINAL RADIO COMMUNICATION UNIT
114
DELIVERY DATA STORAGE UNIT
TERMINAL APPARATUS

FIG. 6

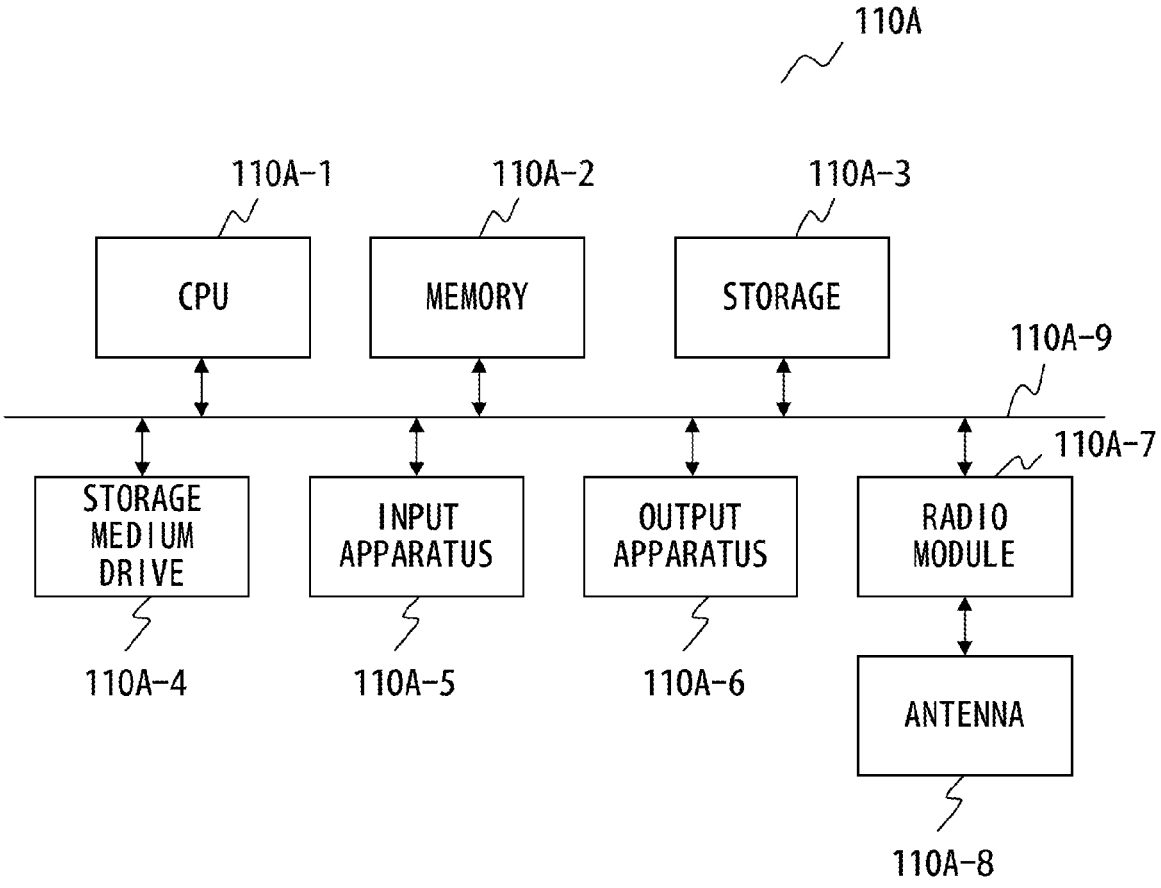

110A
110A-1
110A-2
110A-3
CPU
MEMORY
STORAGE
110A-9
110A-7
STORAGE MEDIUM DRIVE
INPUT APPARATUS
OUTPUT APPARATUS
RADIO MODULE
ANTENNA
110A-4
110A-5
110A-6
110A-8

FIG. 7

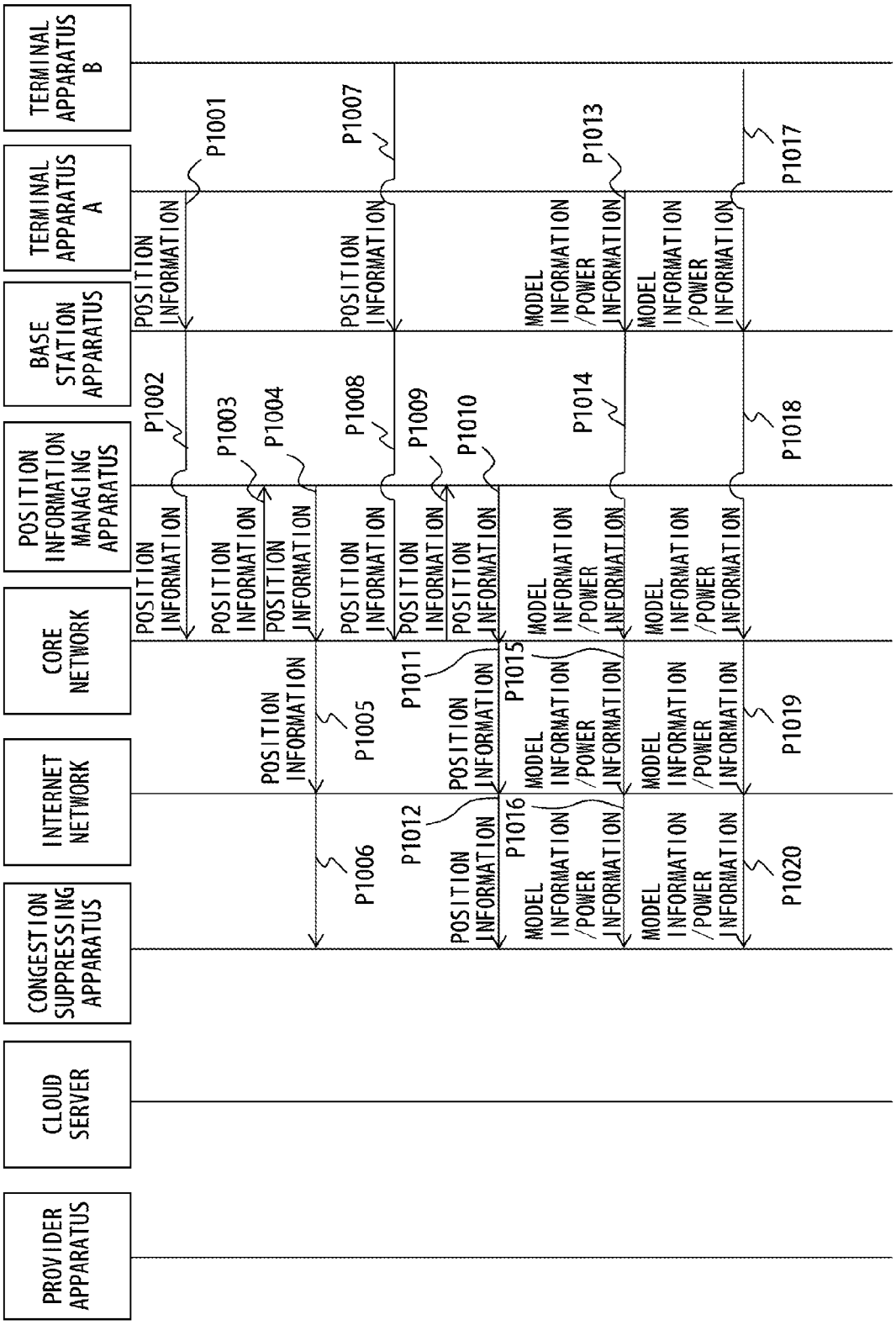

PROVIDER APPARATUS
CLOUD SERVER
CONGESTION SUPPRESSING APPARATUS
INTERNET NETWORK
CORE NETWORK
POSITION INFORMATION MANAGING APPARATUS
BASE STATION APPARATUS
TERMINAL APPARATUS A
TERMINAL APPARATUS B
P1001
P1002
P1003
P1004
P1005
P1006
P1007
P1008
P1009
P1010
P1011
P1012
P1013
P1014
P1015
P1016
P1017
P1018
P1019
P1020
POSITION INFORMATION
MODEL INFORMATION /POWER INFORMATION
MODEL INFORMATION /POWER INFORMATION

FIG. 8

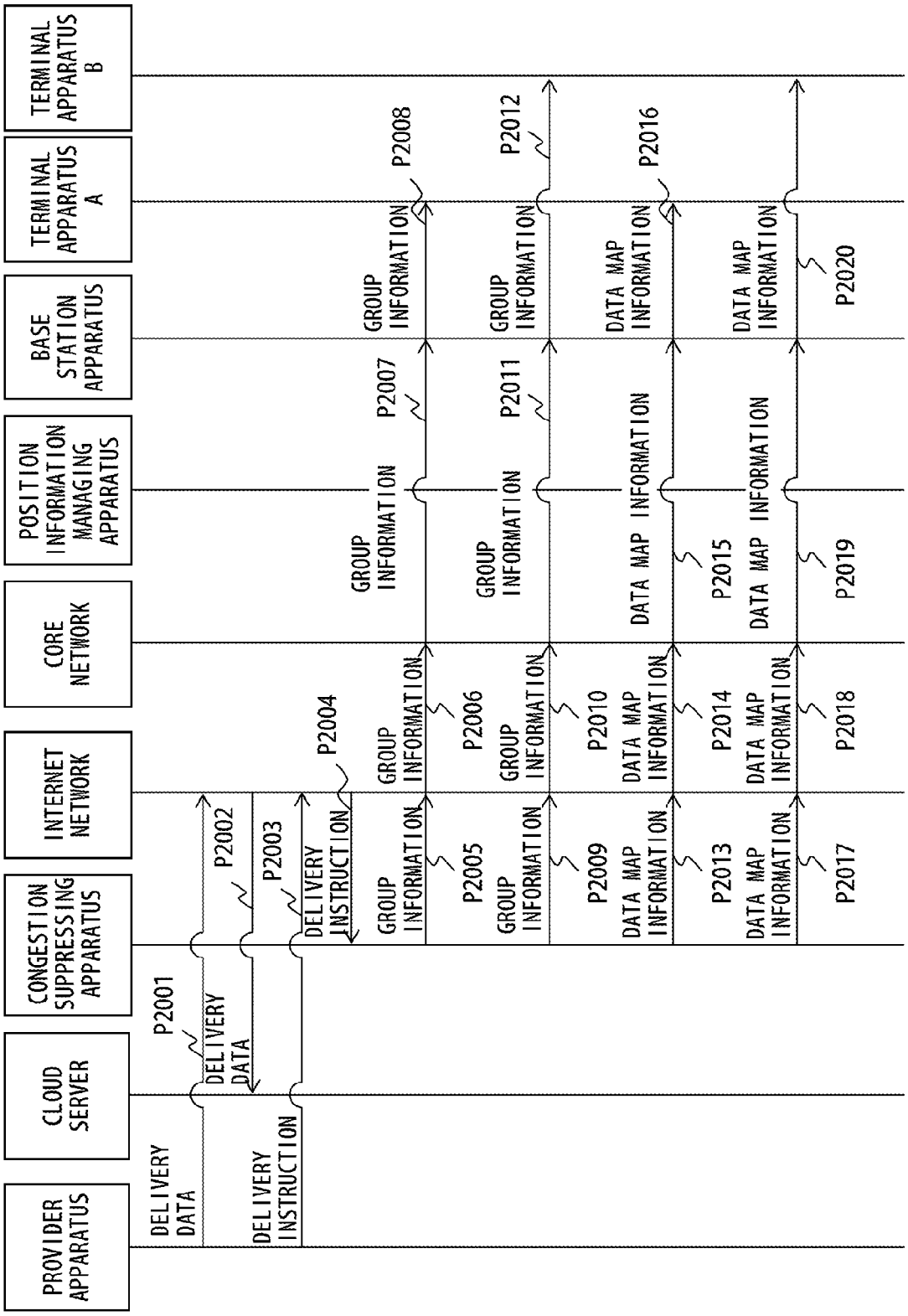

PROVIDER APPARATUS
CLOUD SERVER
CONGESTION SUPPRESSING APPARATUS
INTERNET NETWORK
CORE NETWORK
POSITION INFORMATION MANAGING APPARATUS
BASE STATION APPARATUS
TERMINAL APPARATUS A
TERMINAL APPARATUS B
DELIVERY DATA
DELIVERY INSTRUCTION
P2001
P2002
P2003
P2004
P2005
P2006
P2007
P2008
P2009
P2010
P2011
P2012
P2013
P2014
P2015
P2016
P2017
P2018
P2019
P2020
GROUP INFORMATION
DATA MAP INFORMATION

FIG. 9A

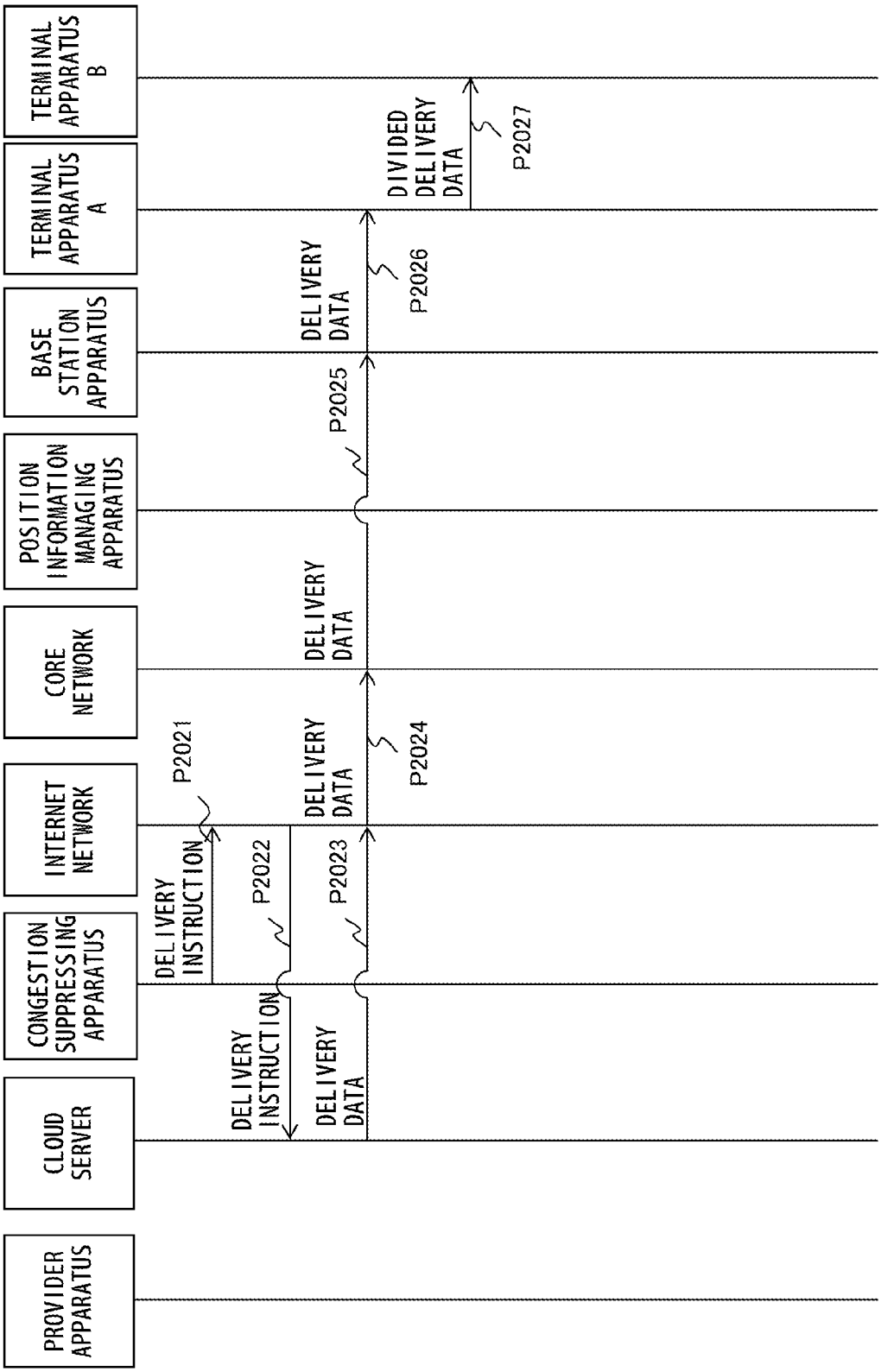

PROVIDER APPARATUS
CLOUD SERVER
CONGESTION SUPPRESSING APPARATUS
INTERNET NETWORK
CORE NETWORK
POSITION INFORMATION MANAGING APPARATUS
BASE STATION APPARATUS
TERMINAL APPARATUS A
TERMINAL APPARATUS B
DELIVERY INSTRUCTION
P2021
P2022
DELIVERY INSTRUCTION
DELIVERY DATA
P2023
DELIVERY DATA
P2024
DELIVERY DATA
P2025
DELIVERY DATA
P2026
DIVIDED DELIVERY DATA
P2027

FIG. 9B

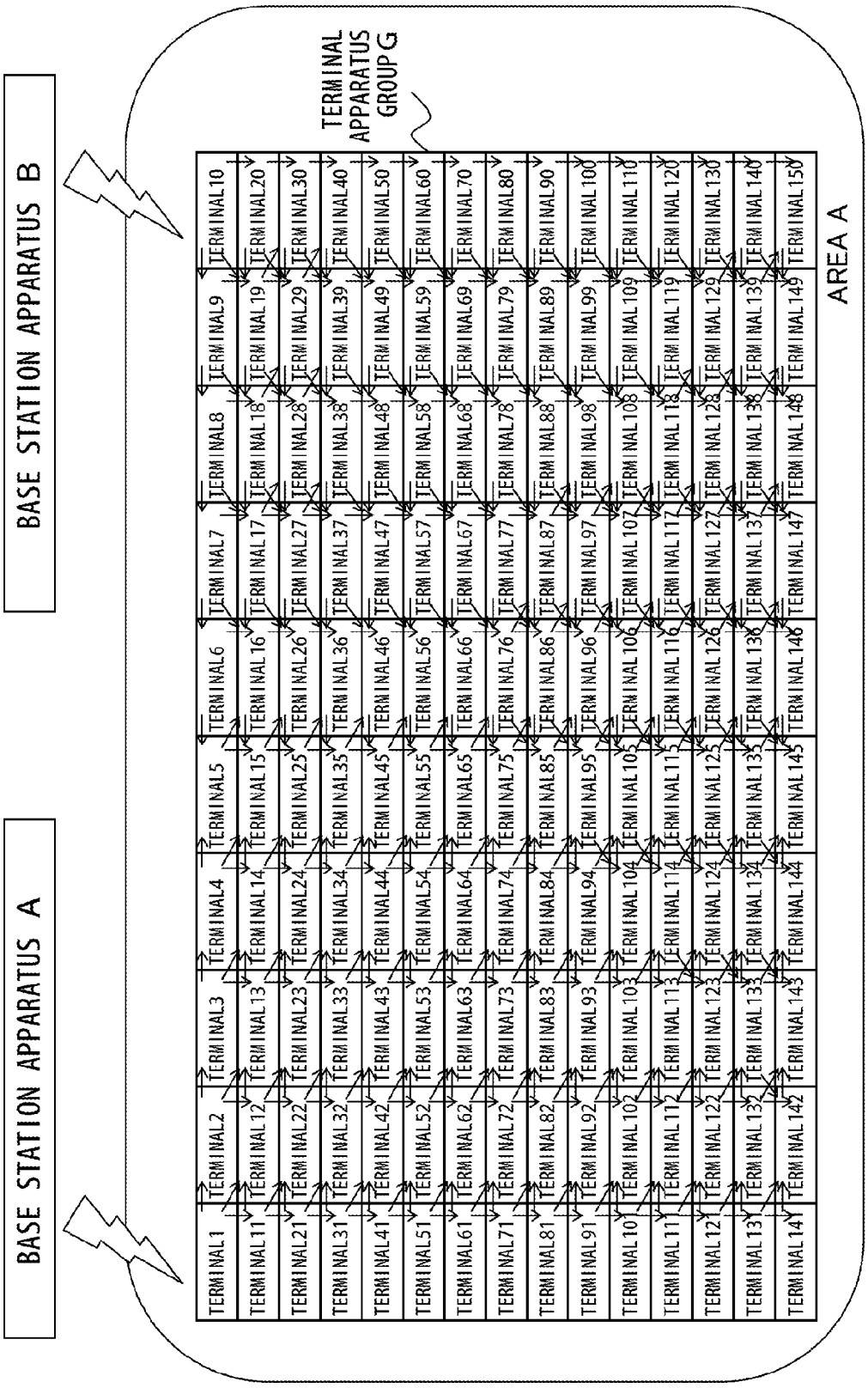

BASE STATION APPARATUS A
BASE STATION APPARATUS B
TERMINAL APPARATUS GROUP G
AREA A

FIG. 10

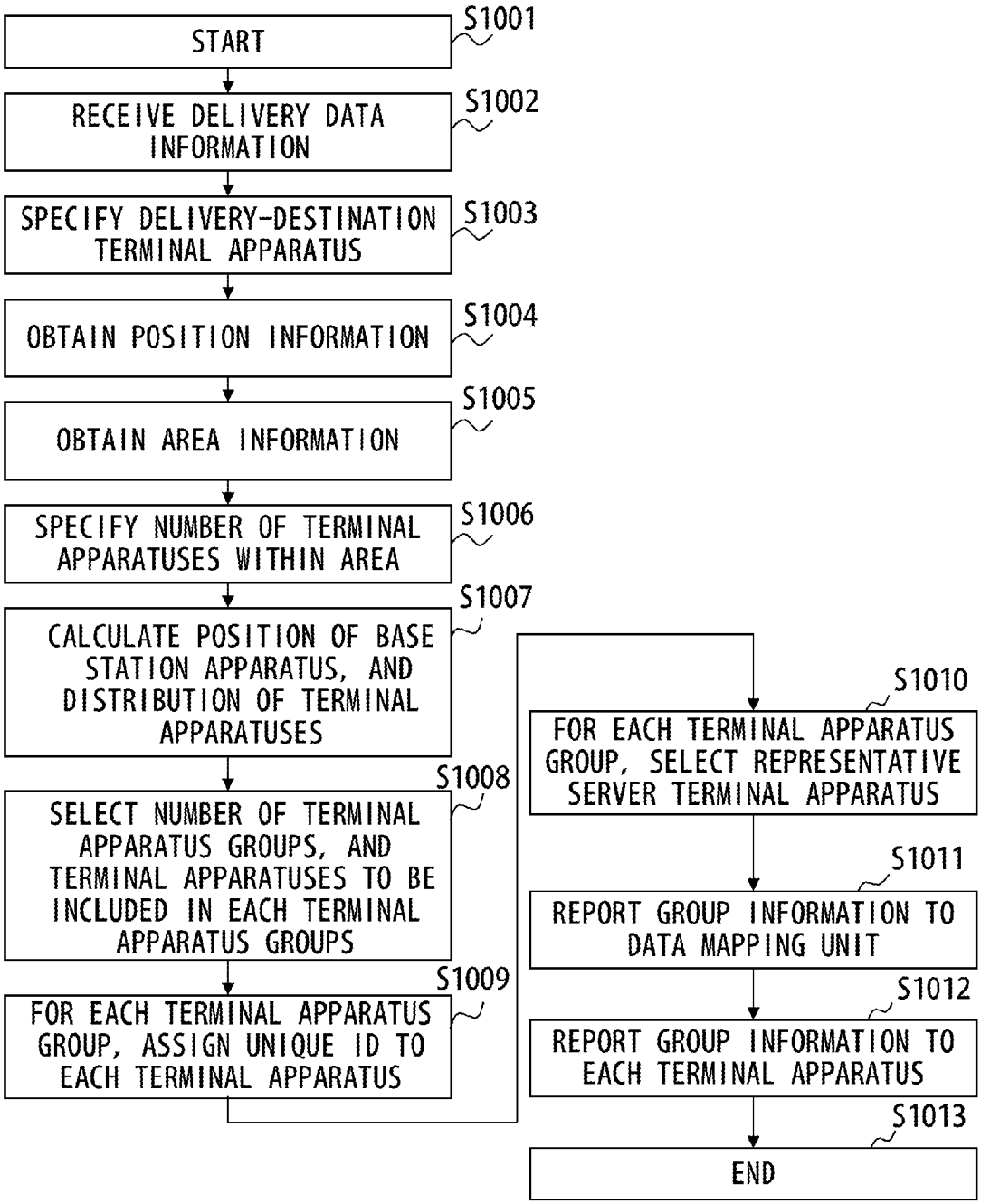

START
S1001
RECEIVE DELIVERY DATA INFORMATION
S1002
SPECIFY DELIVERY-DESTINATION TERMINAL APPARATUS
S1003
OBTAIN POSITION INFORMATION
S1004
OBTAIN AREA INFORMATION
S1005
SPECIFY NUMBER OF TERMINAL APPARATUSES WITHIN AREA
S1006
CALCULATE POSITION OF BASE STATION APPARATUS, AND DISTRIBUTION OF TERMINAL APPARATUSES
S1007
SELECT NUMBER OF TERMINAL APPARATUS GROUPS, AND TERMINAL APPARATUSES TO BE INCLUDED IN EACH TERMINAL APPARATUS GROUPS
S1008
FOR EACH TERMINAL APPARATUS GROUP, ASSIGN UNIQUE ID TO EACH TERMINAL APPARATUS
S1009
FOR EACH TERMINAL APPARATUS GROUP, SELECT REPRESENTATIVE SERVER TERMINAL APPARATUS
S1010
REPORT GROUP INFORMATION TO DATA MAPPING UNIT
S1011
REPORT GROUP INFORMATION TO EACH TERMINAL APPARATUS
S1012
END
S1013

FIG. 11

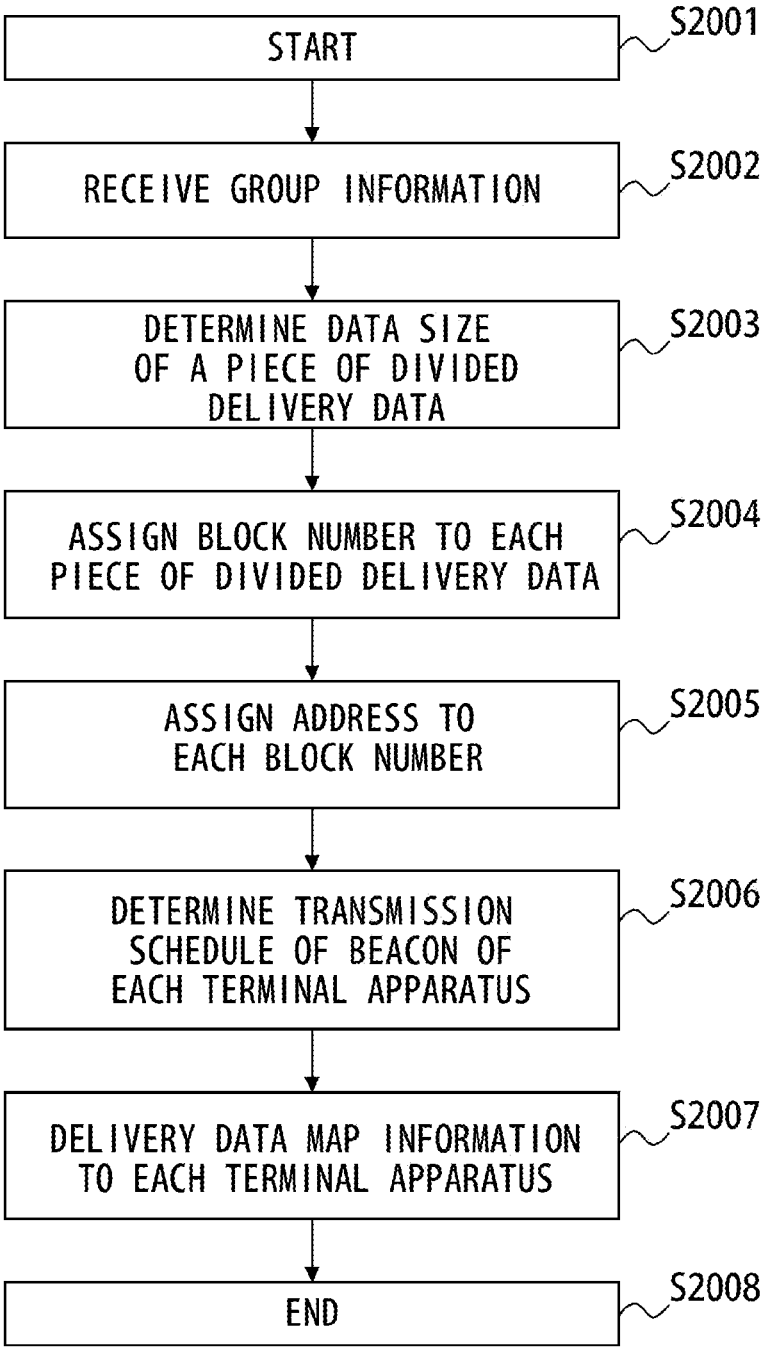

START
S2001
RECEIVE GROUP INFORMATION
S2002
DETERMINE DATA SIZE OF A PIECE OF DIVIDED DELIVERY DATA
S2003
ASSIGN BLOCK NUMBER TO EACH PIECE OF DIVIDED DELIVERY DATA
S2004
ASSIGN ADDRESS TO EACH BLOCK NUMBER
S2005
DETERMINE TRANSMISSION SCHEDULE OF BEACON OF EACH TERMINAL APPARATUS
S2006
DELIVERY DATA MAP INFORMATION TO EACH TERMINAL APPARATUS
S2007
END
S2008

FIG. 12

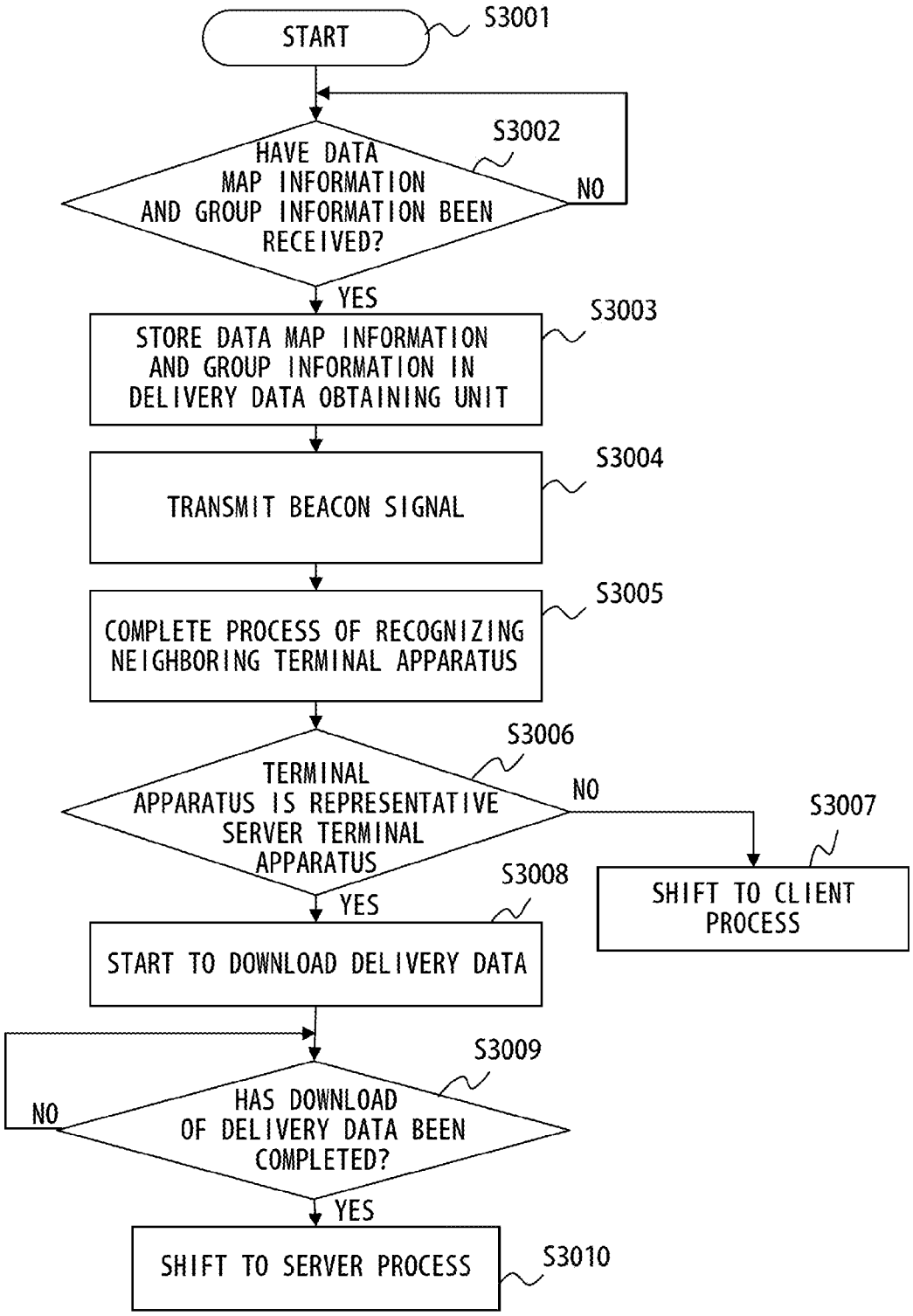

START
S3001
HAVE DATA MAP INFORMATION AND GROUP INFORMATION BEEN RECEIVED?
S3002
NO
YES
STORE DATA MAP INFORMATION AND GROUP INFORMATION IN DELIVERY DATA OBTAINING UNIT
S3003
TRANSMIT BEACON SIGNAL
S3004
COMPLETE PROCESS OF RECOGNIZING NEIGHBORING TERMINAL APPARATUS
S3005
TERMINAL APPARATUS IS REPRESENTATIVE SERVER TERMINAL APPARATUS
S3006
NO
SHIFT TO CLIENT PROCESS
S3007
YES
START TO DOWNLOAD DELIVERY DATA
S3008
HAS DOWNLOAD OF DELIVERY DATA BEEN COMPLETED?
S3009
NO
YES
SHIFT TO SERVER PROCESS
S3010

FIG. 13

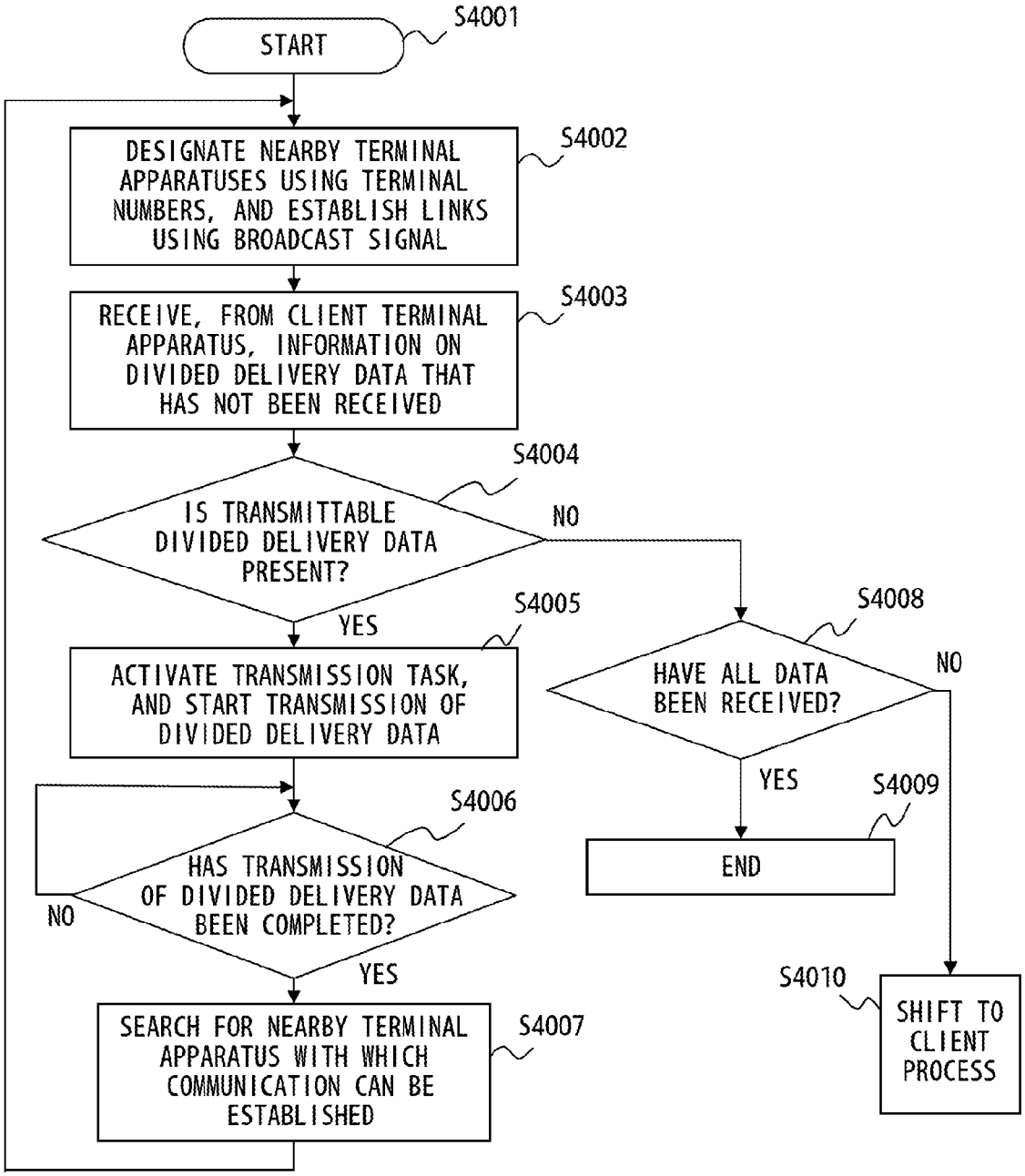

START
S4001
DESIGNATE NEARBY TERMINAL APPARATUSES USING TERMINAL NUMBERS, AND ESTABLISH LINKS USING BROADCAST SIGNAL
S4002
RECEIVE, FROM CLIENT TERMINAL APPARATUS, INFORMATION ON DIVIDED DELIVERY DATA THAT HAS NOT BEEN RECEIVED
S4003
IS TRANSMITTABLE DIVIDED DELIVERY DATA PRESENT?
S4004
NO
YES
ACTIVATE TRANSMISSION TASK, AND START TRANSMISSION OF DIVIDED DELIVERY DATA
S4005
HAS TRANSMISSION OF DIVIDED DELIVERY DATA BEEN COMPLETED?
S4006
NO
YES
SEARCH FOR NEARBY TERMINAL APPARATUS WITH WHICH COMMUNICATION CAN BE ESTABLISHED
S4007
HAVE ALL DATA BEEN RECEIVED?
S4008
NO
YES
END
S4009
SHIFT TO CLIENT PROCESS
S4010

FIG. 14

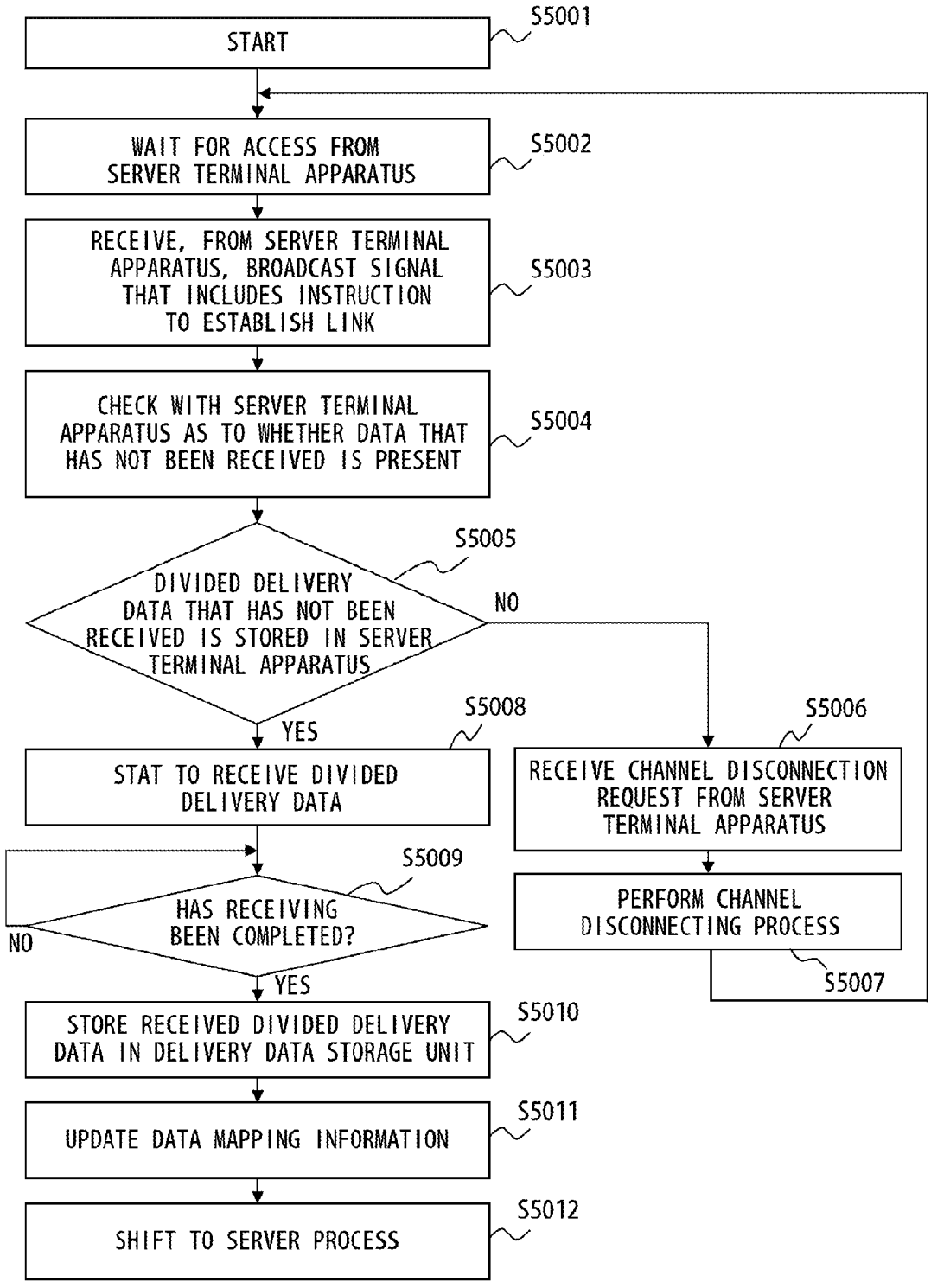

START
S5001
WAIT FOR ACCESS FROM SERVER TERMINAL APPARATUS
S5002
RECEIVE, FROM SERVER TERMINAL APPARATUS, BROADCAST SIGNAL THAT INCLUDES INSTRUCTION TO ESTABLISH LINK
S5003
CHECK WITH SERVER TERMINAL APPARATUS AS TO WHETHER DATA THAT HAS NOT BEEN RECEIVED IS PRESENT
S5004
DIVIDED DELIVERY DATA THAT HAS NOT BEEN RECEIVED IS STORED IN SERVER TERMINAL APPARATUS
S5005
NO
YES
STAT TO RECEIVE DIVIDED DELIVERY DATA
S5008
RECEIVE CHANNEL DISCONNECTION REQUEST FROM SERVER TERMINAL APPARATUS
S5006
HAS RECEIVING BEEN COMPLETED?
S5009
NO
YES
PERFORM CHANNEL DISCONNECTING PROCESS
S5007
STORE RECEIVED DIVIDED DELIVERY DATA IN DELIVERY DATA STORAGE UNIT
S5010
UPDATE DATA MAPPING INFORMATION
S5011
SHIFT TO SERVER PROCESS
S5012

FIG. 15

RADIO ACCESS SYSTEM, CONTROLLING APPARATUS, AND TERMINAL APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2014-027462, filed on Feb. 17, 2014, the entire contents of which are incorporated herein by reference.

FIELD

The embodiments discussed herein are related to a radio access system, a controlling apparatus, and a terminal apparatus.

BACKGROUND

In recent years, communications have been unable to be established in some cases because many terminal apparatuses use packet communication services provided by a radio communication system beyond the capacity of a communications infrastructure such as a base station apparatus. Recently, cellular phones called "smartphones" and information communication terminal apparatuses called "tablet terminals" have tended to become widespread. Terminal apparatuses, including cellular phones and information communication terminal apparatuses, could be capable of downloading data of large size such as still images and moving images from a data delivery server via a base station apparatus. Accordingly, in an area where many terminal apparatuses may possibly be present, a case could occur where a data delivery server attempts to simultaneously deliver data of large size to many terminal apparatuses via abase station apparatus that covers communications in that area. If that case happens in a best-effort communication service wherein a plurality of terminal apparatuses could share the bandwidth of communications infrastructures, congestion may possibly occur in a particular communications infrastructure within a radio commutation system.

Specific examples of areas where many terminal apparatuses may possibly be present include, for example, sites for seminars, concert venues, event sites, and rush-hour station yards. In such areas, many terminal apparatuses may be geographically concentrated beyond the capacity of a base station apparatus that covers communications in that area. Data delivered from a data delivery server to many terminal apparatuses within such an area includes, for example, texts delivered from a promoter to guests, site guides with pictures, moving-picture-based schedules, apps needed to attend an event, moving-image data for setting the mood for a concert prior to the start, information for emergency guidance in a venue or station yard, and lost child reports. The data includes information to be shared among many users within the area, and hence an attempt is made to deliver the data to individual terminal apparatuses of many users within the area. Making an attempt to deliver data to many terminal apparatuses within a particular area may cause processing intended for those many terminal apparatuses to be excessively concentrated on a particular communications infrastructure such as a base station apparatus that covers communications in that area, leading to congestion in the particular communications infrastructure.

As described above, in a particular area where many terminal apparatuses could be present, since congestion may possibly occur in a particular communications infrastructure within a radio communication system, it is difficult to simultaneously deliver data of large size from a data delivery server to the many terminal apparatuses.

The following is known as a technology related to a local network for mobile communication devices. A mobile terminal is connected to other mobile terminals so as to form an ad-hoc local network. The mobile terminal determines whether a file requested by a user is available from the local network. When the file is available via the local network, the mobile terminal retrieves the file from the local network. In a case where the file is not available via the local network, when the file is available on a cellular network generated by a base station, the mobile terminal retrieves the file from the cellular network.

In addition, the following is known as a technology related to a wireless ad-hoc network. Each wireless terminal connected to a wireless ad-hoc network retrieves other wireless terminals existing in a communication range by wireless communication to create a neighboring terminal list. Each wireless terminal selects a group leader candidate terminal based on a predetermined selection criterion from the created neighboring terminal list, and carries out a request for a group leader for the selected group leader candidate terminal. The wireless terminal having received the request for a group leader sends acceptance or rejection. Each wireless terminal reports to the other wireless terminals in the neighboring terminal list that the group leader in the own group thereof has been selected.

PRIOR ART DOCUMENTS

Patent Documents

Patent document 1: Japanese National Publication of International Patent Application No. 2009-538019

Patent document 2: Japanese Laid-open Patent Publication No. 2010-45525

SUMMARY

According to an aspect of the embodiments, a radio access system includes a controlling apparatus and a terminal apparatus. The controlling apparatus receives position information transmitted from terminal apparatuses, and stores the received position information. The controlling apparatus obtains, from among the stored position information, position information of destination terminal apparatuses to which delivery data is to be delivered. When the destination terminal apparatuses are judged to be concentrated in a particular area in accordance with the obtained position information, the controlling apparatus groups the destination terminal apparatuses present in the particular area together as a terminal apparatus group. The controlling apparatus selects a representative server terminal apparatus from the terminal apparatuses included in the terminal apparatus group. The controlling apparatus transmits group information related to the terminal apparatuses included in the terminal apparatus group to each of the terminal apparatuses included in the terminal apparatus group. The controlling apparatus creates data map information indicating a delivery rule for delivering the delivery data from the representative server terminal apparatus to another terminal apparatus within the terminal apparatus group. The controlling apparatus adds information for identification of the representative server terminal apparatus to the created data map information, and transmit the data map information to each of the terminal apparatuses included in the terminal apparatus group. The controlling apparatus

instructs a delivery data server to deliver the delivery data to the representative server terminal apparatus. The terminal apparatus transmits the position information of the terminal apparatus to the controlling apparatus. The terminal apparatus receives the group information and data map information transmitted from the controlling apparatus. The terminal apparatus obtains the delivery data that the representative server terminal apparatus has obtained from the delivery data server, by communicating, in accordance with the received data map information, with the another terminal apparatus within the terminal apparatus group included in the received group information.

The object and advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the claims.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of the invention.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is an exemplary configuration diagram of a radio access system in accordance with an embodiment;

FIG. **2** is an exemplary functional configuration diagram of a congestion suppressing apparatus in accordance with an embodiment;

FIG. **3** is an exemplary diagram of a group information database in accordance with an embodiment;

FIG. **4** is an exemplary diagram of data map information in accordance with an embodiment;

FIG. **5** is an exemplary hardware configuration diagram of a congestion suppressing apparatus in accordance with an embodiment;

FIG. **6** is an exemplary functional configuration diagram of a terminal apparatus in accordance with an embodiment;

FIG. **7** is an exemplary hardware configuration diagram of a terminal apparatus in accordance with an embodiment;

FIG. **8** is an exemplary sequence diagram of a process of obtaining position information, the process being performed by a radio access system in accordance with an embodiment;

FIG. **9**A is an exemplary sequence diagram of data delivery performed by a radio access system in accordance with an embodiment;

FIG. **9**B is an exemplary sequence diagram of data delivery performed by a radio access system in accordance with an embodiment;

FIG. **10** is an explanatory diagram of an exemplary terminal apparatus group for which data delivery is performed in accordance with an embodiment;

FIG. **11** is an exemplary flow diagram of a process of generating group information, the process being performed by a congestion suppressing apparatus in accordance with an embodiment;

FIG. **12** is an exemplary flow diagram of a process of generating data map information, the process being performed by a congestion suppressing apparatus in accordance with an embodiment;

FIG. **13** is an exemplary flow diagram of a process of obtaining delivery data, the process being performed by a terminal apparatus in accordance with an embodiment;

FIG. **14** is an exemplary flow diagram of a server process performed by a terminal apparatus in accordance with an embodiment; and

FIG. **15** is an exemplary flow diagram of a client process performed by a terminal apparatus in accordance with an embodiment.

DESCRIPTION OF EMBODIMENTS

The following will describe embodiments with reference to the drawings.

FIG. **1** is an exemplary configuration diagram of a radio access system in accordance with an embodiment. As illustrated in FIG. **1**, a radio access system **1** includes a provider apparatus **10**, a cloud server **20**, a position information managing apparatus **30**, an Internet network **40**, and a core network **50**. The radio access system **1** also includes a congestion suppressing apparatus **60**, a first base station apparatus **70**, a first-base-station controlling apparatus **80**, a second base station apparatus **90**, an access point apparatus **100**, and terminal apparatuses **110-1** to **110-6**. In the of the radio access system **1** depicted in FIG. **1**, the position information managing apparatus **30**, the core network **50**, the first base station apparatus **70**, the first-base-station controlling apparatus **80**, the second base station apparatus **90**, and the access point apparatus **100** are included in a radio access network that connects the terminal apparatuses **110-1** to **110-6** to the Internet network **40**.

The plurality of terminal apparatuses **110-1** to **110-6** will hereinafter be referred to as a "terminal apparatus **110**" when these apparatuses are not particularly distinguished from each other. The first base station apparatus **70**, the second base station apparatus **90**, and the access point apparatus **100** will hereinafter simply be referred to as a "base station apparatus" when these apparatuses are not particularly distinguished from each other.

The provider apparatus **10** connects an information processing apparatus (not illustrated) of a user, such as a promoter of a seminar or event, to the Internet network **40**. The provider apparatus **10** includes a delivery data managing unit **11**, an Access Point (AP) controlling unit **12**, and an Internet Protocol Interface (IP-IF) unit **13**.

The delivery data managing unit **11** receives and holds delivery data **11**A and delivery data information **11**B transmitted from an information processing apparatus (not illustrated) of a user. Delivery data **11**A is data to be transmitted to a terminal apparatus **110** designated by the information processing apparatus of the user. Delivery data information **11**B includes information on the terminal apparatus **110** to which delivery data **11**A is delivered, and the data size of delivery data **11**A. The delivery data managing unit **11** transmits the delivery data **11**A that has been held to the cloud server **20** via the IP-IF unit **13**. The delivery data managing unit **11** also transmits the delivery data information **11**B that has been held to the congestion suppressing apparatus **60** via the IP-IF unit **13**.

The access point apparatus **100** performs control on the access point controlling unit **12**. The provider apparatus **10** is connected to the Internet network **40** via the IP-IF unit **13**.

The cloud server **20** is a data delivery server that stores the delivery data **11**A transmitted from the provider apparatus **10** and that delivers the stored delivery data **11**A to a predetermined destination apparatus. The cloud server **20** includes a delivery data storage unit **21** and an IP-IF unit **22**. The cloud server **20** is connected to the Internet network **40** via the IP-IF unit **22**.

The delivery data storage unit **21** receives the delivery data **11**A transmitted from the provider apparatus **10** via the IP-IF unit **22**, and stores the received delivery data in a delivery data database (DB) **21**A. The delivery data storage unit **21** also receives, from the congestion suppressing apparatus **60** via the IP-IF unit **22**, a request to transmit the delivery data **11**A stored in the delivery data database **21**A to a predetermined terminal apparatus **110**. In response to a received request, the

delivery data storage unit **21** transmits the delivery data **11**A stored in the delivery data database **21**A to the predetermined terminal apparatus **110** via the IP-IF unit **22**.

The position information managing apparatus **30** manages position information indicating the position of a terminal apparatus **110** included in the radio access system **1**. The position information managing apparatus **30** includes a position information managing unit **31**, a communication interface (IF) unit **32**, and an IP-IF unit **33**.

The position information managing unit **31** receives position information transmitted from each terminal apparatus **110** via the communication interface unit **32**, and records each piece of the received position information in a position information management database (DB) **31**A. The position information managing apparatus **30** is connected to the core network **50** via the communication interface unit **32** and to the Internet network **40** via the IP-IF unit **33**. The core network **50** is an Internet Protocol (IP) core network that connects a radio access network and the Internet network **40** to each other.

The congestion suppressing apparatus **60** is an exemplary controlling apparatus in accordance with an embodiment. The congestion suppressing apparatus **60** obtains position information of a terminal apparatus **110** via the position information managing apparatus **30**. The congestion suppressing apparatus **60** receives a delivery instruction for delivery data **11**A from the provider apparatus **10**. Using the obtained position information, the congestion suppressing apparatus **60** specifies terminal apparatuses **110** geographically concentrated in a particular area from among the terminal apparatuses **110** to which delivery data **11**A is to be delivered. The congestion suppressing apparatus **60** groups the specified terminal apparatuses **110** together as a terminal apparatus group. To identify each of the grouped terminal apparatuses **110**, the congestion suppressing apparatus **60** assigns a unique terminal apparatus number to each of the terminal apparatuses **110**. The congestion suppressing apparatus **60** selects a representative server terminal apparatus from the grouped terminal apparatuses **110** included in the terminal apparatus group.

The representative server terminal apparatus is a terminal apparatus **110** that, on behalf of all of the terminal apparatuses **110** within the terminal apparatus group, receives delivery data **11**A from the cloud server **20** via a base station apparatus and transmits the received delivery data to the other terminal apparatuses **110** within the terminal apparatus group. The representative server terminal apparatus receives delivery data **11**A from the cloud server **20** via abase station apparatus on behalf of all of the terminal apparatuses **110** within the terminal apparatus group, so that congestion in a communications infrastructure such as a base station apparatus may be suppressed in delivering delivery data **11**A from the side of the radio access network to each terminal apparatus **110** within the terminal apparatus group.

The congestion suppressing apparatus **60** divides delivery data **11**A into a plurality of pieces of divided delivery data and generates data map information indicating the position of each piece of divided delivery data within delivery data **11**A. As will be described in detail hereinafter, the delivery data **11**A received by the representative server terminal apparatus is delivered to each of the terminal apparatuses **110** within the terminal apparatus group via communications between the terminal apparatuses **110** included in the terminal apparatus group. Accordingly, dividing delivery data **11**A into a plurality of pieces of divided delivery data shortens the cycle of transmission and reception of the delivery data **11**A between the terminal apparatuses **110**, thereby shortening the wait time for transmission and/or reception of delivery data **11**A. Such a configuration allows delivery data **11**A to be completely delivered from the representative server terminal apparatus to each of the terminal apparatuses **110** within the terminal apparatus group in a short time.

The congestion suppressing apparatus **60** transmits, as group information, information on the terminal apparatus group that includes the grouped terminal apparatuses **110** to each of the terminal apparatuses **110** included in the terminal apparatus group. In addition, the congestion suppressing apparatus **60** adds terminal apparatus information to the data map information for delivery data **11**A and transmits the data map information to which terminal apparatus information has been added to each of the terminal apparatuses **110** included in the terminal apparatus group. Terminal apparatus information includes the terminal apparatus number of a terminal apparatus **110** to which data map information is transmitted. Terminal apparatus information further includes information indicating whether or not the terminal apparatus **110** is a representative server terminal apparatus. The terminal apparatus number may be used to distinguish whether or not the terminal apparatus **110** is a representative server terminal apparatus.

FIG. **2** is an exemplary functional configuration diagram of a congestion suppressing apparatus in accordance with an embodiment. As illustrated in FIG. **2**, the congestion suppressing apparatus **60** includes a position information managing unit **61**, a grouping unit **62**, a data mapping unit **63**, and an IP-IF unit **64**. The congestion suppressing apparatus **60** is connected to the Internet network **40** via the IP-IF unit **64**.

The position information managing unit **61** obtains, via the IP-IF unit **64**, position information of each of the terminal apparatuses **110** held by the position information managing apparatus **30**, and records the obtained position information in a position information management database (DB) **61**A in association with an identifier of the terminal apparatus **110**. The position information managing unit **61** obtains area information such as a map or building information from a map-data providing server (not illustrated) and/or an area quality server (not illustrated), and holds the obtained area information. The map-data providing server is a server to provide map data, e.g., Google Maps, and may be connected to the Internet network **40**. The area quality server is a server to collect information indicating the current position of a terminal apparatus **110** and information indicating a radio quality for that position. The area quality server may be connected to the core network **50**.

When a delivery instruction for delivery data **11**A is received from the provider apparatus **10** via the IP-IF unit **64**, the grouping unit **62** obtains, from the position information managing unit **61**, position information of the terminal apparatuses **110** to which delivery data **11**A is to be delivered. The grouping unit **62** also obtains, from the position information managing unit **61**, area information of a neighboring area of the position indicated by the obtained position information. The grouping unit **62** compares the obtained position information and the obtained area information with each other and specifies terminal apparatuses **110** geographically concentrated in a particular area from among the delivery-destination terminal apparatuses **110**. The particular area is, for example, an event site, concert venue, or station yard. The grouping unit **62** groups the specified terminal apparatuses **110** together as a terminal apparatus group.

To identify each of the grouped terminal apparatuses **110** included in the terminal apparatus group, the grouping unit **62** assigns a unique terminal apparatus number to each of the terminal apparatuses **110**. The grouping unit **62** also selects one or more representative server terminal apparatuses from

the grouped terminal apparatuses **110** included in the terminal apparatus group. The grouping unit **62** stores in a group information database **62**A, as group information, information on the terminal apparatus group, such as the terminal apparatus number of each of the terminal apparatuses **110** included in the terminal apparatus group and/or information on the representative server terminal apparatus. FIG. **3** is an exemplary diagram of a group information database in accordance with an embodiment. In the depicted in FIG. **3**, the group information database **62**A includes six pieces of group information. Each piece of group information includes an "area number", a "total number of terminals", a "group identifier (ID)", and a "terminal apparatus number". An area number indicates a number indicating a particular area corresponding to a terminal apparatus group. The total number of terminals indicates the number of terminal apparatuses **110** included in the terminal apparatus group. A group identifier indicates a unique number for identification of each terminal apparatus group. A terminal apparatus number may identify a representative server terminal apparatus. The grouping unit **62** transmits group information to the data mapping unit **63**. The grouping unit **62** also transmits group information to each terminal apparatus **110** within a terminal apparatus group via the IP-IF unit **64**.

The data mapping unit **63** receives a delivery instruction for delivery data **11**A from the provider apparatus **10** via the IP-IF unit **64**. The delivery instruction received from the provider apparatus **10** includes delivery data information **11**B. Delivery data information **11**B is information on the delivery data **11**A which an information processing apparatus of a user has made a request for the provider apparatus **10** to deliver. Delivery data information **11**B includes identification information of a delivery-destination terminal apparatus **110** designated by the information processing apparatus of the user, and the data size of the delivery data **11**A. The data mapping unit **63** records the received delivery data information **11**B in a delivery data information database **63**A.

The data mapping unit **63** receives group information from the grouping unit **62**. Using the data size of the received delivery data **11**A and the number of terminal apparatuses **110** included in the terminal apparatus group indicated by the received group information, the data mapping unit **63** determines a division size of delivery data **11**A. The data mapping unit **63** generates a plurality of pieces of divided delivery data by dividing delivery data **11**A in accordance with the determined division size. The data mapping unit **63** creates data map information for delivery data **11**A by assigning addresses indicating the positions of the pieces of divided delivery data within delivery data **11**A to the pieces of divided delivery data. FIG. **4** is an exemplary diagram of data map information in accordance with an embodiment. In the depicted in FIG. **4**, delivery data **11**A is divided into **120** pieces of divided delivery data indicated by block numbers **1-120**. In the example depicted in FIG. **4**, the **120** pieces of divided delivery data are each assigned any of two dimensional addresses consisting of X addresses **1-30** and Y addresses **1-4**. The two dimensional addresses each specify the position of a piece of divided delivery data within delivery data **11**A.

The data mapping unit **63** transmits the created data map information to each of the terminal apparatuses **110** within the terminal apparatus group via the IP-IF unit **64**.

FIG. **5** is an exemplary hardware configuration diagram of a congestion suppressing apparatus in accordance with an embodiment. As illustrated in FIG. **5**, a congestion suppressing apparatus **60**A includes a Central Processing Unit (CPU) **60**A-**1**, a memory **60**A-**2**, a storage **60**A-**3**, a storage medium drive **60**A-**4**, an input apparatus **60**A-**5**, an output apparatus **60**A-**6**, a communication interface **60**A-**7**, and a bus **60**A-**8**. The CPU **60**A-**1**, the memory **60**A-**2**, the storage **60**A-**3**, the storage medium drive **60**A-**4**, the input apparatus **60**A-**5**, the output apparatus **60**A-**6**, and the communication interface **60**A-**7** are connected to each other by the bus **60**A-**8**.

The CPU **60**A-**1** is a logical circuit that performs arithmetic processing. The memory **60**A-**2** is a main storage apparatus which is directly accessible by the CPU **60**A-**1**. The memory **60**A-**2** temporarily stores data during processing and a program in the process of being executed by the CPU **60**A-**1**. The memory **60**A-**2** is, for example, a Synchronous Dynamic Random Access Memory (SDRAM). The CPU **60**A-**1** and the memory **60**A-**2** may correspond to the position information managing unit **61**, the grouping unit **62**, and the data mapping unit **63**.

The storage **60**A-**3** is, for example, a Hard Disk Drive (HDD) or flash memory. The storage **60**A-**3** stores various programs and data to be executed by the CPU **60**A-**1**. The storage **60**A-**3** may correspond to the position information management database **61**A, the group information database **62**A, and the delivery data information database **63**A.

The storage medium drive **60**A-**4** is an apparatus for reading data recorded in a recording medium and/or writing data processed by the CPU **60**A-**1** to the recording medium. The recording medium is, for example, a Compact Disk Read Only Memory (CD-ROM), Digital Versatile Disk (DVD), Universal Serial Bus (USB) memory, Secure Digital (SD) card, or flash memory.

The input apparatus **60**A-**5** is an apparatus used by the user of the congestion suppressing apparatus **60**A to input an instruction to the congestion suppressing apparatus **60**A. The input apparatus **60**A-**5** is, for example, a keyboard, mouse, or touch panel. The output apparatus **60**A-**6** is an apparatus for displaying a processing result of the CPU **60**A-**1**. The output apparatus **60**A-**6** is, for example, a liquid crystal display. The communication interface **60**A-**7** is an apparatus for establishing a connection to an external packet network such as the Internet network. The communication interface **60**A-**7** may correspond to the IP-IF unit **64**.

The first base station apparatus **70** depicted in FIG. **1** is a base station apparatus wirelessly connected to a terminal apparatus **110** having a communication function conforming to a first communication standard. The first communication standard is, for example, a Third Generation (3G) communication standard defined by a specification of Third Generation Partnership Project (3GPP). The first base station apparatus **70** includes a radio communication unit **71** and a communication interface (IF) unit **72**.

The first base station apparatus **70** transmits signals to and receives signals from the terminal apparatus **110** via the radio communication unit **71**, the terminal apparatus **110** conforming to the first communication standard. The first base station apparatus **70** also transmits signals to and receives signals from the first-base-station controlling apparatus **80** via the communication interface unit **72**. Although FIG. **1** depicts one first base station apparatus **70**, the radio access system **1** may include any number of first base station apparatuses **70**.

The first-base-station controlling apparatus **80** is a radio network controlling apparatus that manages corresponding first base station apparatuses **70**. The first-base-station controlling apparatus **80** includes a communication interface (IF) unit **81**, and transmits signals to and receives signals from the first base station apparatus **70** and the core network **50** via the communication interface unit **81**. Although FIG. **1** depicts

one first-base-station controlling apparatus **80**, the radio access system **1** may include any number of first-base-station controlling apparatuses **80**.

The second base station apparatus **90** is a base station apparatus wirelessly connected to a terminal apparatus **110** having a communication function conforming to a second communication standard. The second communication standard is, for example, the Long Term Evolution (LTE) defined by a specification of 3GPP. The second base station apparatus **90** includes a radio communication unit **91** and a communication interface (IF) unit **92**.

The second base station apparatus **90** transmits signals to and receives signals from the terminal apparatus **110** via the radio communication unit **91**, the terminal apparatus **110** conforming to the second communication standard. The second base station apparatus **90** also transmits signals to and receives signals from the core network **50** via the communication interface unit **92**. Although FIG. **1** depicts one second base station apparatus **90**, the radio access system **1** may include any number of second base station apparatuses **90**.

The access point apparatus **100** is a communication apparatus wirelessly connected to a terminal apparatus **110** having a communication function conforming to a third communication standard. The third communication standard is a standard for a wireless Local Area Network (LAN), e.g., Wireless Fidelity (WiFi). A terminal apparatus **110** having a communication function conforming to the first or second communication standard may have a communication function conforming to the third communication standard. The access point apparatus **100** includes a radio communication unit **101** and an IP-IF unit **102**.

The access point apparatus **100** transmits signals to and receives signals from the terminal apparatus **110** via the radio communication unit **101**, the terminal apparatus **110** conforming to the third communication standard. The access point apparatus **100** is connected to the Internet network **40** via the IP-IF unit **102**. Although FIG. **1** depicts one access point apparatus **100**, the radio access system **1** may include any number of access point apparatuses **100**.

The terminal apparatuses **110-1** to **110-6** are, for example, User Equipment (UE) defined by a specification of 3GPP, and include a cellular phone called a smartphone and an information communication terminal apparatus called a tablet terminal.

In the example depicted in FIG. **1**, the terminal apparatuses **110-1** and **110-2** are wirelessly connected to the first base station apparatus **70** in accordance with the first communication standard, and perform communications via the first base station apparatus **70**; the terminal apparatuses **110-3** and **110-4** are wirelessly connected to the second base station apparatus **90** in accordance with the second communication standard, and perform communications via the second base station apparatus **90**; and the terminal apparatuses **110-5** and **110-6** are wirelessly connected to the access point apparatus **100** in accordance with the third communication standard, and perform communications via the access point apparatus **100**. FIG. **1** depicts an example for illustrating the radio access system **1**, and any number of terminal apparatuses **110** can be connected to each base station apparatus.

In the example depicted in FIG. **1**, the terminal apparatuses **110-1** and **110-2** are wirelessly connected to each other in accordance with a fourth communication standard, and communications are performed therebetween; the terminal apparatuses **110-3** and **110-4** are wirelessly connected to each other in accordance with the fourth communication standard, and communications are performed therebetween; and the terminal apparatuses **110-5** and **110-6** are wirelessly connected to each other in accordance with the fourth communication standard, and communications are performed therebetween. The fourth communication standard is a short-distance radio communication standard, e.g., WiFi, Bluetooth, or Near Field Communication (NFC). FIG. **1** depicts an example for illustrating the radio access system **1**; one terminal apparatus **110** may be wirelessly connected to a plurality of terminal apparatuses **110** in accordance with the fourth communication standard, and the one terminal apparatus **110** may communicate with the plurality of terminal apparatuses **110**.

FIG. **6** is an exemplary functional configuration diagram of a terminal apparatus in accordance with an embodiment. As illustrated in FIG. **6**, the terminal apparatus **110** includes a terminal information transmitting unit **111**, a delivery information receiving unit **112**, a delivery data obtaining unit **113**, a delivery data storage unit **114**, a radio communication unit **115**, and an inter-terminal radio communication unit **116**.

The terminal information transmitting unit **111** transmits position information indicating the position of the terminal apparatus **110** to the position information managing apparatus **30** via the radio communication unit **115**. The terminal information transmitting unit **111** may transmit model information and/or power information of the terminal apparatus **110** to the congestion suppressing apparatus **60** via the radio communication unit **115**. The power information of the terminal apparatus **110** indicates, for example, the battery residual quantity of the terminal apparatus **110** and the state of a connection to an external power source such as an Alternative Current (AC) power source.

The delivery information receiving unit **112** receives group information and data map information from the congestion suppressing apparatus **60** via the radio communication unit **115**. Group information is information on a terminal apparatus group that includes a terminal apparatus **110** to which delivery data **11**A is to be delivered. The group information received by the delivery information receiving unit **112** is group information on a terminal apparatus group that includes the terminal apparatus **110**. Data map information indicates a data map for pieces of divided delivery data obtained by dividing delivery data **11**A. The data map information received by the delivery information receiving unit **112** is data map information for the delivery data **11**A for which the terminal apparatus **110** is designated as a delivery-destination terminal apparatus **110**.

The delivery information receiving unit **112** may receive the delivery data **11**A transmitted from the cloud server **20** via the radio communication unit **115**. When, for example, the terminal apparatus **110** is a representative server terminal apparatus, the delivery information receiving unit **112** receives the delivery data **11**A transmitted from the cloud server **20** via the radio communication unit **115**. The delivery information receiving unit **112** stores the received delivery data **11**A in the delivery data storage unit **114**.

The delivery data obtaining unit **113** performs a process for obtaining delivery data **11**A via communication between terminal apparatuses **110**. The delivery data obtaining unit **113** receives group information and data map information from the delivery information receiving unit **112**. The delivery data obtaining unit **113** records the received group information in a group information database (DB) **113**A and records the received data map information in a data map information database (DB) **113**B. The delivery data obtaining unit **113** transmits a piece of divided delivery data specified by data map information to and receives such a piece of divided data from a terminal apparatus **110** included in a terminal apparatus group indicated by group information via the inter-terminal radio communication unit **116**.

A terminal apparatus **110** to which or from which the delivery data obtaining unit **113** directly transmits or receives pieces of divided delivery data is another terminal apparatus **110** that is capable of performing communication in accordance with the fourth communication standard and that is located in the vicinity of the terminal apparatus **110**. To cause a neighboring terminal apparatus **110** to recognize the presence of the terminal apparatus **110**, the delivery data obtaining unit **113** may transmit a beacon signal to the neighboring terminal apparatus **110** via the inter-terminal radio communication unit **116** at a unique transmission timing assigned to each terminal apparatus **110** within the terminal apparatus group.

The delivery data obtaining unit **113** transmits pieces of divided delivery data stored in the delivery data storage unit **114** to a neighboring terminal apparatus **110** via the inter-terminal radio communication unit **116**. The delivery data obtaining unit **113** also receives pieces of divided delivery data transmitted from the neighboring terminal apparatus **110** via the inter-terminal radio communication unit **116** and stores these pieces of divided data in the delivery data storage unit **114**.

The pieces of divided delivery data stored in the delivery data storage unit **114** are assembled in accordance with the data map information received by the delivery data obtaining unit **113**. When all of the pieces of divided delivery data included in delivery data **11**A are stored in the delivery data storage unit **114**, the pieces of divided delivery data within the delivery data storage unit **114** are combined into one piece of delivery data **11**A.

The radio communication unit **115** is connected to a base station apparatus in accordance with one of the first to third communication standards, and transmits signals to and receives signals from the base station apparatus. The inter-terminal radio communication unit **116** is connected to an neighboring terminal apparatus **110** of the terminal apparatus **110** in accordance with the fourth communication standard, and transmits signals to and receives signals from the neighboring terminal apparatus **110**.

FIG. **7** is an exemplary hardware configuration diagram of a terminal apparatus in accordance with an embodiment. As illustrated in FIG. **7**, a terminal apparatus **110**A includes a CPU **110**A-**1**, a memory **110**A-**2**, a storage **110**A-**3**, a storage medium drive **110**A-**4**, an input apparatus **110**A-**5**, an output apparatus **110**A-**6**, a radio module **110**A-**7**, an antenna **110**A-**8**, and a bus **110**A-**9**. The CPU **110**A-**1**, the memory **110**A-**2**, the storage **110**A-**3**, the storage medium drive **110**A-**4**, the input apparatus **110**A-**5**, the output apparatus **110**A-**6**, and the radio module **110**A-**7** are connected to each other by the bus **110**A-**9**.

The CPU **110**A-**1** is a logical circuit that performs arithmetic processing. The memory **110**A-**2** is a main storage apparatus which is directly accessible by the CPU **110**A-**1**. The memory **110**A-**2** temporarily stores data during processing and a program in the process of being executed by the CPU **110**A-**1**. The memory **110**A-**2** is, for example, an SDRAM. The CPU **110**A-**1** and the memory **110**A-**2** may correspond to the terminal information transmitting unit **111**, the delivery information receiving unit **112**, and the delivery data obtaining unit **113**.

The storage **110**A-**3** is, for example, a hard disk drive or flash memory. The storage **110**A-**3** stores various programs and data to be executed by the CPU **110**A-**1**. The storage **110**A-**3** may correspond to the group information database **113**A and the data map information database **113**B.

The storage medium drive **110**A-**4** is an apparatus for reading data recorded in a recording medium and/or writing data processed by the CPU **110**A-**1** to the recording medium. The recording medium is, for example, a CD-ROM, DVD, USB memory, SD card, or flash memory.

The input apparatus **110**A-**5** is an apparatus used by the user of the terminal apparatus **110**A to input an instruction to the terminal apparatus **110**A. The input apparatus **110**A-**5** is, for example, a keyboard, mouse, or touch panel. The output apparatus **110**A-**6** is an apparatus for displaying a processing result of the CPU **110**A-**1**. The output apparatus **110**A-**6** is, for example, a liquid crystal display. The radio module **110**A-**7** is an apparatus that transmits and receives radio signals via an antenna **110**-**9** in accordance with any of the first to fourth communication standards. The radio module **110**A-**7** may correspond to the radio communication unit **115** and the inter-terminal radio communication unit **116**.

The following will describe an exemplary data delivering process performed by the radio access system **1**.

First, the congestion suppressing apparatus **60** obtains position information of a terminal apparatus **110** included in the radio access system **1**. The congestion suppressing apparatus **60** may obtain model information and/or power information of the terminal apparatus **110** included in the radio access system **1**. FIG. **8** is an exemplary sequence diagram of a process of obtaining position information, the process being performed by a radio access system in accordance with an embodiment.

In FIG. **8**, terminal apparatuses A and B are examples of terminal apparatus **110** included in the radio access system **1**. Each terminal apparatus **110** is connected to abase station apparatus from which a broadcast signal with a satisfactory radio quality is received from among the neighboring base station apparatuses of the terminal apparatus **110**. The base station apparatus to which a connection is established may be any of the first base station apparatus **70**, the second base station apparatus **90**, or the access point apparatus **100**. When a connection to the first base station apparatus **70** is established, signals are transmitted and received between the terminal apparatus **110** and the core network **50** via the connected first base station apparatus **70** and the first-base-station controlling apparatuses **80**.

The terminal apparatus A transmits position information of the terminal apparatus A to the position information managing apparatus **30** via the core network **50** and the base station apparatus to which the terminal apparatus A has been connected (processes P**1001**-P**1003**). The position information managing apparatus **30** records the received position information in the position information management database **31**A. The position information managing apparatus **30** also transmits the received position information to the congestion suppressing apparatus **60** via the core network **50** and the Internet network **40** (processes P**1004**-P**1006**). The position information managing unit **61** of the congestion suppressing apparatus **60** receives the position information transmitted from the position information managing apparatus **30** via the IP-IF unit **64**, and records the received position information in the position information management database **61**A.

In addition, the terminal apparatus B transmits position information of the terminal apparatus B to the position information managing apparatus **30** via the core network **50** and the base station apparatus to which the terminal apparatus B has been connected (processes P**1007**-P**1009**). The position information managing apparatus **30** records the received position information in the position information management database **31**A. The position information managing apparatus **30** also transmits the received position information to the congestion suppressing apparatus **60** via the core network **50** and the Internet network **40** (processes P**1010**-P**1012**). The

position information managing unit **61** of the congestion suppressing apparatus **60** receives the position information transmitted from the position information managing apparatus **30** via the IP-IF unit **64**, and records the received position information in the position information management database **61**A.

The terminal apparatus A may transmit model information and/or power information of the terminal apparatus A to the congestion suppressing apparatus **60** via the base station apparatus to which the terminal apparatus A has been connected, the core network **50**, and the Internet network **40** (processes P**1013**-P**1016**). The position information managing unit **61** of the congestion suppressing apparatus **60** may receive and hold the model information and/or power information transmitted from the terminal apparatus A via the IP-IF unit **64**. The terminal apparatus B may transmit model information and/or power information of the terminal apparatus B to the congestion suppressing apparatus **60** via the base station apparatus to which the terminal apparatus B has been connected, the core network **50**, and the Internet network **40** (processes P**1017**-P**1020**). The position information managing unit **61** of the congestion suppressing apparatus **60** may receive and hold the model information and/or power information transmitted from the terminal apparatus B via the IP-IF unit **64**.

It should be noted that the sequence of the process of obtaining position information illustrated in FIG. **8** is an example. For example, each of the terminal apparatuses **110** such as the terminal apparatuses A and B may transmit a radio quality measurement signal, e.g., Measurement Report, into which the position information of the terminal apparatus **110** has been incorporated. The terminal apparatus **110** may transmit model information and/or power information of the terminal apparatus **110** together with position information.

Performing the process of obtaining position information as described above causes the position information managing unit **61** to obtain position information indicating the current position of each terminal apparatus **110** included in the radio access system **1**. The position information managing unit **61** also obtains model information and/or power information of each terminal apparatus **110** included in the radio access system **1**. The position information managing unit **61** obtains area information such as a map or building information from a map-data providing server and/or an area quality server and holds the obtained area information.

FIGS. **9**A and **9**B are exemplary sequence diagrams of data delivery performed by a radio access system in accordance with an embodiment. The provider apparatus **10** receives and holds delivery data **11**A and delivery data **11**B from an information processing apparatus of a user. The provider apparatus **10** transmits delivery data **11**A to the cloud server **20** via the Internet network **40** and uploads delivery data **11**A onto the cloud server **20** (processes P**2001**-P**2002**). The cloud server **20** records the received delivery data **11**A in the delivery data database **21**A.

The provider apparatus **10** gives, over the Internet network **40**, the congestion suppressing apparatus **60** an instruction to deliver delivery data **11**A (processes P**2003**-P**2004**). The delivery instruction transmitted from the provider apparatus **10** includes delivery data information **11**B. Delivery data information **11**B includes the data size of delivery data **11**A and information on a terminal apparatus **110** to which delivery data **11**A is to be delivered.

The congestion suppressing apparatus **60** receives from the provider apparatus **10** an instruction to deliver delivery data **11**A. Then, the congestion suppressing apparatus **60** generates delivery information for delivering delivery data **11**A from the cloud server **20** to a delivery-destination terminal apparatus **110**. The generated delivery information includes group information and data map information. With reference to FIGS. **10**-**12**, the following will describe a process of generating delivery information performed by the congestion suppressing apparatus **60**.

FIG. **10** is an explanatory diagram of an exemplary terminal apparatus group for which data delivery is performed in accordance with an embodiment. In the example depicted in FIG. **10**, **150** terminal apparatuses **110** with terminal apparatus numbers **1**-**150** are present within a particular area A. The particular area A is, for example, an event site, particular building, or station yard. In the example depicted in FIG. **10**, the two base station apparatuses such as base station apparatuses A and B cover communications within the particular area. Alternatively, when, as the example of FIG. **10** indicates, the two base station apparatuses cover communications within the particular area, a terminal apparatus **110** may be connected to the base station apparatus A, and another terminal apparatus **110** may be connected to the base station apparatus B. When a communication area covered by the base station apparatus A at least partially overlaps a communication area covered by the base station apparatus B, a terminal apparatus **110** may be connected to the base station apparatus A for a satisfactory radio quality, and another terminal apparatus **110** may be connected to the base station apparatus B for a satisfactory radio quality. First and second base station apparatuses may each be any of the first base station apparatus **70**, the second base station apparatus **90**, or the access point apparatus **100**. FIG. **10** depicts an example, and any number of terminal apparatuses **110** may be present within the particular area. Communications within the particular area may be covered by one base station apparatus, or may be covered by three or more base station apparatuses.

FIG. **11** is an exemplary flow diagram of a process of generating group information, the process being performed by a congestion suppressing apparatus in accordance with an embodiment. When a processing sequence for generating delivery information starts (step S**1001**), the data mapping unit **63** receives a delivery instruction transmitted from the provider apparatus **10** via the IP-IF unit **64** (step S**1002**). In the example depicted in FIG. **10**A, a delivery instruction to deliver data to terminal apparatuses **110** including the terminal apparatuses **110** with terminal apparatus numbers **1**-**150** is received.

The data mapping unit **63** refers to the delivery data information **11**B included in the received delivery instruction and obtains identification information of terminal apparatuses **110** to which delivery data **11**A is to be delivered. Using the obtained identification information of the terminal apparatuses **110**, the data mapping unit **63** specifies the delivery-destination terminal apparatuses **110** (step S**1003**). Terminal apparatuses **110** including the terminal apparatuses **110** with terminal apparatus numbers **1**-**150** are specified in the example of FIG. **10**.

The data mapping unit **63** transmits a transmission request for position information of the delivery-destination terminal apparatuses **110** to the position information managing unit **61**. Upon receipt of the transmission request, the position information managing unit **61** obtains, from the position information management database, the position information of the terminal apparatuses **110** to which delivery data **11**A is to be delivered, and transmits the obtained position information to the grouping unit **62** and the data mapping unit **63**. The grouping unit **62** and the data mapping unit **63** receive the position information transmitted from the position information managing unit **61**, i.e., obtain the position information of

the delivery-destination terminal apparatuses **110** (step S**1004**). Position information with terminal apparatuses **110** including the terminal apparatuses **110** with terminal apparatus numbers **1**-**150** is obtained in the example of FIG. **10**.

The grouping unit **62** transmits, to the position information managing unit **61**, a transmission request for area information of an area that includes positions indicated by the position information of the delivery-destination terminal apparatuses **110**. The position information managing unit **61** transmits, to the grouping unit **62**, the area information of the area that includes the positions of the delivery-destination terminal apparatuses **110**. The grouping unit **62** receives the area information transmitted from the position information managing unit **61**, i.e., obtains the area information of the area that includes the positions of the delivery-destination terminal apparatuses **110** (step S**1005**). The area information of a particular area A is obtained in the example of FIG. **10**.

Using the obtained area information, the grouping unit **62** specifies the number of delivery-destination terminal apparatuses **110** within the particular area (step S**1006**). The number of terminal apparatuses **110** is **150** in the example of FIG. **10**.

The grouping unit **62** specifies a base station apparatus that covers communications performed by the delivery-destination terminal apparatuses **110** located within the particular area. One or more base station apparatuses may be specified. In the example of FIG. **10**, two base station apparatuses (base station apparatuses A and B) are specified.

The grouping unit **62** calculates the position of the specified base station apparatus and the number of terminal apparatuses **110** present within the communication area of the specified base station apparatus (step S**1007**). Information on base station apparatuses, e.g., the position of each of the base station apparatuses included in the radio access system **1**, covered communication areas, and processing capacities, is set in advance within the congestion suppressing apparatus **60**. The grouping unit **62** may obtain the set information on the base station apparatuses. As the processing capacity of each base station apparatus, a predetermined value is set in advance according to a memory capacity and the number of terminal apparatuses **110** that the base station apparatus can accommodate.

The grouping unit **62** selects the number of terminal apparatus groups to which the delivery-destination terminal apparatuses **110** located within the particular area are to belong, and selects delivery-destination terminal apparatuses **110** to be included in each of the terminal apparatus groups (step S**1008**). In one possible example, using the number of delivery-destination terminal apparatuses **110** located within a particular area, the processing capacity of a specified base station apparatus, and a requested delivery rate, the grouping unit **62** selects the number of terminal apparatus groups and terminal apparatuses **110** to be included in each of the terminal apparatus groups. The requested delivery rate is a delivery rate requested to be used in delivering delivery data **11**A to all of the delivery-destination terminal apparatuses **110** located within the particular area.

When, for example, the number of delivery-destination terminal apparatuses **110** located within the particular area is greater than a predetermined value, the grouping unit **62** selects a plurality of terminal apparatus groups and selects terminal apparatuses **110** to be included in each of the selected terminal apparatus groups. When it is determined that the processing capacity of the specified base station apparatus is low relative to the number of delivery-destination terminal apparatuses **110** located within the particular area, the grouping unit **62** selects a plurality of terminal apparatus groups and selects terminal apparatuses **110** to be included in each of the selected terminal apparatus groups. In addition, when it is determined that the requested delivery rate for delivery data **11**A is high, the grouping unit selects a plurality of terminal apparatus groups and selects terminal apparatuses **110** to be included in each of the selected terminal apparatus groups.

In the example of FIG. **10**, one terminal apparatus group G is selected, and **150** terminal apparatuses **110** to be included in the terminal apparatus group G are selected.

The grouping unit **62** assigns a unique group identifier to each of the selected terminal apparatus groups. For each of the selected terminal apparatus groups, the grouping unit **62** assigns a unique terminal apparatus number to each terminal apparatus **110** included in the terminal apparatus group (step S**1009**).

For each of the selected terminal apparatus groups, the grouping unit **62** selects one or more representative server terminal apparatuses from the terminal apparatuses **110** included in the terminal apparatus group (step S**1010**).

In one possible example, the grouping unit **62** selects the number of representative server terminal apparatuses for the terminal apparatus group in accordance with the scale of the terminal apparatus group and a requested delivery rate of delivery data **11**A. When the requested delivery rate of the delivery data is high, the grouping unit **62** selects a plurality of representative server terminal apparatuses for the terminal apparatus group. On the other hand, when the requested delivery rate of delivery data **11**A is low, the grouping unit **62** may select one representative server terminal apparatus for the terminal apparatus group. However, when it is determined that the delivery rate will be lower than the requested delivery rate due to a large number of terminal apparatuses **110** being included in the terminal apparatus group, the grouping unit **62** may select a plurality of representative server terminal apparatuses for the terminal apparatus group.

In one possible example, the grouping unit **62** obtains a bandwidth use situation of a specified base station apparatus and selects the number of representative server terminal apparatuses for the terminal apparatus group in accordance with the bandwidth use situation of the base station apparatus and the scale of the terminal apparatus group. When the terminal apparatus group includes a small number of terminal apparatuses **110**, the grouping unit **62** selects one representative server terminal apparatus from the terminal apparatus group. Meanwhile, when the terminal apparatus group includes a large number of terminal apparatuses **110**, a plurality of terminal apparatuses may use the bandwidth of the base station apparatus, leading to a decrease in the rate of communication from the base station apparatus to the plurality of terminal apparatuses **110**. However, the grouping unit **62** selects a plurality of representative server terminal apparatuses from the terminal apparatus group when it is determined that using a plurality of representative server apparatuses will increase the delivery rate within the terminal apparatus group and will shorten the time before all of the terminal apparatuses **110** completely download delivery data **11**A.

For example, the grouping unit **62** may use model information of each terminal apparatus **110** so as to select a terminal apparatus **110** of a model for high-speed communication as a representative server terminal apparatus from the terminal apparatuses **110** included in the terminal apparatus group. The grouping unit **62** may use power information of each terminal apparatus **110** so as to select a terminal apparatus **110** connected to an external power source or whose battery is not easily drained as a representative server terminal apparatus from the terminal apparatuses **110** included in the terminal apparatus group. The grouping unit **62** may sample position

information of terminal apparatuses **110** at certain time intervals so as to select a terminal apparatus **110** that moves a short distance, and is thus not likely to perform handover, as a representative server terminal apparatus from the terminal apparatuses **110** included in the terminal apparatus group.

In the example of FIG. **10**, the terminal apparatus **110** with terminal apparatus number **1** and the terminal apparatus **110** with terminal apparatus number **10** are selected from the terminal apparatus group G as representative server terminal apparatuses.

The grouping unit **62** defines the area number, total number of terminals, group identifier, and terminal apparatus numbers of each terminal apparatus group as group information of the terminal apparatus group, and records the group information of each terminal apparatus in the group information database **62**A. In the example of FIG. **10**, the identification number of the particular area A, the total number of terminal apparatuses **110**, i.e., **150**, the identifier of the terminal apparatus group G, and terminal apparatus numbers **1**-**150** are recorded as group information of the terminal apparatus group G.

The grouping unit **62** reports group information to the data mapping unit **63** (step S**1011**). The data mapping unit **63** transmits the reported group information via the IP-IF unit **64** to each terminal apparatus **110** included in the terminal apparatus group corresponding to the group information (step S**1012**), and the processing sequence for generating group information ends (step S**1013**).

In the aforementioned process of generating group information, the congestion suppressing apparatus **60** transmits group information corresponding to the terminal apparatus group that includes the terminal apparatus A to the terminal apparatus A via the Internet network **40**, the core network **50**, and the base station apparatus to which the terminal apparatus A is connected (processes P**2005**-P**2008**). The congestion suppressing apparatus **60** also transmits group information corresponding to the terminal apparatus group that includes the terminal apparatus B to the terminal apparatus B via the Internet network **40**, the core network **50**, and the base station apparatus to which the terminal apparatus B is connected (processes P**2009**-P**2012**). In the example of FIG. **10**, the terminal apparatuses A and B are terminal apparatuses **110** included in the same terminal apparatus group (terminal apparatus group G).

Performing the process of generating group information triggers a process of generating data map information. FIG. **12** is an exemplary flow diagram of a process of generating data map information, the process being performed by a congestion suppressing apparatus in accordance with an embodiment.

When a processing sequence for generating data map information starts (step S**2001**), the data mapping unit **63** receives group information transmitted from the grouping unit **62** (step S**2002**). Using the data size of delivery data **11**A and the number of terminal apparatuses **110** included in the terminal apparatus group indicated by the received group information, the data mapping unit **63** determines a division size of delivery data **11**A (step S**2003**). In one possible example, the data mapping unit **63** determines the division size of delivery data **11**A by dividing the data size of delivery data **11**A by a multiple of the number of terminal apparatuses **110** (an arbitrary multiple that is one or greater). Allowing divided delivery data **11**A to be transmitted and received between the terminal apparatuses **110** within the terminal apparatus group may shorten the delivery cycle between terminal apparatuses **110**, thereby shortening the wait time for transmission and/or reception of delivery data **11**A.

The data mapping unit **63** generates a plurality of pieces of divided delivery data by dividing delivery data **11**A in accordance with the determined division size. The data mapping unit **63** assigns a unique block number to each piece of divided delivery data (step S**2004**). The block numbers each indicate apiece of divided delivery data included in delivery data **11**A.

The data mapping unit **63** creates data map information for delivery data **11**A by assigning a data address indicating a position within delivery data **11**A to each piece of divided delivery data identified by a block number (step S**2005**). The congestion suppressing apparatus **60** adds terminal apparatus information to the created data map information. Terminal apparatus information includes the terminal apparatus number of the terminal apparatus **110** to which data map information is to be transmitted. Terminal apparatus information also includes information indicating whether the terminal apparatus **110** is a representative server terminal apparatus.

The data mapping unit **63** determines the transmission schedule of a beacon signal from each terminal apparatus **11** included in the terminal apparatus group (step S**2006**). The beacon signal is a signal that is periodically transmitted to report to neighboring terminal apparatuses **110** that the terminal apparatus **110** can receive delivery data **11**A. The data mapping unit **63** determines the transmission schedule of beacon signals in a manner such that each of the terminal apparatuses **110** can transmit the beacon signal at a different unique timing affiliated with group information and based on a time-sharing scheme.

The data mapping unit **63** transmits the data map information to which terminal apparatus information has been added to each terminal apparatus **110** within the terminal apparatus group via the IP-IF unit **64** together with the determined transmission schedule of beacon signals (step S**2007**). Then, the processing sequence for generating data map information ends (step S**2008**).

In the aforementioned process of generating data map information, the congestion suppressing apparatus **60** transmits data map information corresponding to the terminal apparatus group that includes the terminal apparatus A to the terminal apparatus A via the Internet network **40**, the core network **50**, and the base station apparatus to which the terminal apparatus A is connected (processes P**2013**-P**2016**). The congestion suppressing apparatus **60** also transmits data map information corresponding to the terminal apparatus group that includes the terminal apparatus B to the terminal apparatus B via the Internet network **40**, the core network **50**, and the base station apparatus to which the terminal apparatus B is connected (processes P**2017**-P**2020**).

The data mapping unit **63** of the congestion suppressing apparatus **60** gives the cloud server **20**, via the Internet network **40**, an instruction to deliver delivery data **11**A to a representative server terminal apparatus included in the terminal apparatus group. When, for example, the terminal apparatus A is a representative server terminal apparatus and the terminal apparatus B is not a representative server terminal apparatus, the congestion suppressing apparatus **60** instructs the cloud server **20** to deliver delivery data **11**A to the terminal apparatus A (processes P**2021**-P**2022**).

In accordance with the received delivery instruction, the cloud server **20** transmits the delivery data **11**A stored in the delivery data database **21**A to the representative server terminal apparatus via the Internet network **40**, the core network **50**, and the base station apparatus to which the server terminal apparatus is connected. In the of FIG. **9**B, the cloud server **20** transmits delivery data **11**A to the terminal apparatus A (processes P**2023**-P**2026**).

When the representative server terminal apparatus included in the terminal apparatus group receives delivery data **11**A, the received delivery data **11**A is delivered from the representative server terminal apparatus to each terminal apparatus **110** within the terminal apparatus group. In particular, pieces of divided delivery data obtained by dividing the received delivery data **11**A are transmitted and received between the terminal apparatuses **110** within the terminal apparatus group, with the result that each of the terminal apparatuses **110** within the terminal apparatus group downloads delivery data **11**A. In the example depicted in FIG. **9**, the terminal apparatus A transmits pieces of divided delivery data to the terminal apparatus B, i.e., another terminal apparatus **110** which belongs to the same terminal apparatus group as the terminal apparatus A (process P**2027**). The terminal apparatus B receives pieces of divided delivery data transmitted from the terminal apparatus A, and downloads delivery data **11**A by combining the pieces of received divided delivery data. In the example of FIG. **10**, as indicated by arrows representing diffusion starting from the terminal apparatus **110** with terminal apparatus number **1** to other terminal apparatuses **110**, the delivery data **11**A received by the terminal apparatus **110** with terminal apparatus number **1** is divided into pieces of divided delivery data, which are then transmitted and received between neighboring terminal apparatuses **110**. In addition, as indicated by arrows representing diffusion starting from the terminal apparatus **110** with terminal apparatus number **10** to other terminal apparatuses **110**, the delivery data **11**A received by the terminal apparatus **110** with terminal apparatus number **10** is divided into pieces of divided delivery data, which are then transmitted and received between neighboring terminal apparatuses **110**. In this way, the delivery data **11**A received by each of the individual terminal apparatuses **110** with terminal apparatus numbers **1** and **10** is delivered to the terminal apparatuses **110** within the terminal apparatus group G.

With reference to FIGS. **13-15**, the following will describe an exemplary process of obtaining delivery data performed by each terminal apparatus **110** included in a terminal apparatus group. FIG. **13** is an exemplary flow diagram of a process of obtaining delivery data, the process being performed by a terminal apparatus in accordance with an embodiment.

When a processing sequence for obtaining delivery data starts (step S**3001**), the delivery information receiving unit **112** waits for reception of data map information and group information transmitted from the congestion suppressing apparatus **60** and determines whether data map information and group information have been received (step S**3002**). As described above with reference to FIG. **9**A, data map information and group information may each be transmitted at a different timing from the congestion suppressing apparatus **60** to a terminal apparatus **110**. As described above with reference to FIG. **12**, terminal apparatus information is added to data map information and includes information indicating the terminal apparatus number of, and a representative server terminal apparatus for, the terminal apparatus **110** for which the data map information has been received. A unique transmission schedule of a beacon signal of the terminal apparatus **110** may be transmitted together with data map information.

When it is determined that data map information and group information have been received via the radio communication unit **115** ("YES" in step S**3002**), the delivery information receiving unit **112** transmits the received data map information and group information to the delivery data obtaining unit **113**. The delivery data obtaining unit **113** receives the group information transmitted from the delivery information receiving unit **112**, and stores the received group information in the group information database **113**A. The delivery data obtaining unit **113** also receives the data map information transmitted from the delivery information receiving unit **112**, and stores the received data map information in the data map information database **113**B (step S**3003**).

Data map information is stored in the data map information database **113**B in, for example, the table format depicted in FIG. **4**. In the data map information stored in the table format, each block corresponding to a piece of divided delivery data specified by an address is flagged to indicate whether the terminal apparatus **110** has received the piece of divided delivery data.

The delivery data obtaining unit **113** obtains from the delivery information receiving unit **112** the transmission schedule of a beacon signal received together with data map information. In accordance with the obtained delivery schedule, the delivery data obtaining unit **113** transmits the beacon signal, i.e., a signal that includes the terminal apparatus number of the terminal apparatus **110**, to a neighboring terminal apparatus **110** via the inter-terminal radio communication unit **116** (step S**3004**).

The delivery data obtaining unit **113** receives a beacon signal transmitted at a unique timing from a neighboring terminal apparatus **110** via the inter-terminal radio communication unit **116**. The delivery data obtaining unit **113** refers to the terminal apparatus number included in the received beacon signal and specifies a terminal apparatus **110** located in the vicinity of the terminal apparatus **110** (step S**3005**).

In accordance with the terminal apparatus information added to the received data map information, the delivery data obtaining unit **113** determines whether the terminal apparatus **110** that has performed the processing sequence for obtaining delivery data is a representative server terminal apparatus (step S**3006**).

When it is determined that the terminal apparatus **110** is not a representative server terminal apparatus ("NO" in step S**3006**), the delivery data obtaining unit **113** performs a client process (step S**3007**). The client process is a process wherein the terminal apparatus **110** obtains, from a neighboring terminal apparatus, the divided delivery data held by the neighboring terminal apparatus **110**. Divided delivery data is data obtained by dividing the delivery data **11**A downloaded by a representative server terminal apparatus in accordance with a delivery rule indicated by data map information. Details of the client process will be described hereinafter with reference to FIG. **15**.

When it is determined that the terminal apparatus **110** is a representative server terminal apparatus ("YES" in step S**3006**), the delivery information receiving unit **112** starts to download the delivery data **11**A transmitted from the cloud server **20** in accordance with a transmission instruction from the congestion suppressing apparatus **60** (step S**3008**). That is, the delivery information receiving unit **112** stores the delivery data **11**A transmitted from the cloud server **20** in the delivery data storage unit **114**.

When the delivery data **11**A transmitted from the cloud server **20** is stored in the delivery data storage unit **114**, i.e., when the download of the delivery data **11**A is completed ("YES" in S**3009**), the delivery information receiving unit **112** reports the completion of the download of delivery data **11**A to the delivery data obtaining unit **113**. The delivery data obtaining unit **113** flags every block within the data map information recorded in the data map information database **113**B in such a manner as to indicate that the terminal apparatus **110** has received divided delivery data. The delivery data obtaining unit **113** performs a server process (step S**3010**). The server process is a process wherein the terminal

apparatus **110** transmits the divided delivery data held by the terminal apparatus **110** to a neighboring terminal apparatus. Details of the server process will be described with reference to FIG. **14**.

FIG. **14** is an exemplary flow diagram of a server process performed by a terminal apparatus in accordance with an embodiment. FIG. **15** is an exemplary flow diagram of a client process performed by a terminal apparatus in accordance with an embodiment.

A representative server terminal apparatus may perform the server process depicted in FIG. **14**. A server apparatus **110** that has performed a client process may perform the server process depicted in FIG. **14**. A terminal apparatus **110** that is not a representative server terminal apparatus may perform the client process depicted in FIG. **15**. In the following descriptions, a terminal apparatus **110** that performs the server process will be referred to as a server terminal apparatus, and a terminal apparatus **110** that performs the client process will be referred to as a client terminal apparatus. A terminal apparatus **110** that is not a representative server terminal apparatus may be a server terminal apparatus that performs the server process depicted in FIG. **14**, or may be a client terminal apparatus that performs the client process depicted in FIG. **15**.

First, with reference to FIG. **14**, a description will be given of an exemplary server process performed by a terminal apparatus **110** in accordance with an embodiment.

When the terminal apparatus **110** serves as a server terminal apparatus to start a server processing sequence (step **S4001**), the delivery data obtaining unit **113** of the terminal apparatus **110** transmits a broadcast signal to neighboring terminal apparatuses **110** via the inter-terminal radio communication unit **116** and establishes links to the neighboring terminal apparatuses **110** (step **S4002**). The broadcast signal transmitted from the delivery data obtaining unit **113** includes the terminal apparatus numbers of the neighboring terminal apparatuses **110** and includes an instruction to establish a link to the terminal apparatus **110** that is a server terminal apparatus. The terminal apparatuses **110** to which the links have been established serve as client terminal apparatuses.

The delivery data obtaining unit **113** receives, via the inter-terminal radio communication unit **116**, information on a piece of divided delivery data that has not been received by a client terminal apparatus to which the link has been established (step **S4003**). Information on a piece of divided delivery data that has not been received is transmitted from each client terminal apparatus to which the link has been established.

As described above with reference to FIG. **10**, the terminal apparatuses **110** included in a terminal apparatus group other than the representative server terminal apparatus each obtain delivery data **11**A by exchanging pieces of divided delivery data with neighboring terminal apparatuses **110**. Hence, the client terminal apparatuses that have established a link to the terminal apparatus **110** may include a client terminal apparatus that has not received a piece of divided delivery data from a neighboring server terminal apparatus. Information on a piece of divided delivery data that has not been received by a client terminal apparatus may be, for example, a unique address assigned to the piece of divided delivery data or the block number of the piece of divided delivery data.

According to information on divided delivery data that has not been received, the delivery data obtaining unit **113** determines whether a piece of transmittable divided delivery data is stored in the delivery data storage unit **114** (step **S4004**). Specifically, the delivery data obtaining unit **113** refers to the data map information recorded in the data map information database **113**B. Then, the delivery data obtaining unit **113** determines whether a block corresponding to apiece of divided delivery data that has not been received by a client terminal apparatus to which a link has been established has been flagged to indicate that the terminal apparatus **110** has received the piece of divided delivery data.

When it is determined that a piece of transmittable divided delivery data is stored in the delivery data storage unit **114** ("YES" in step **S4004**), the delivery data obtaining unit **113** obtains the piece of transmittable divided delivery data from the delivery data storage unit **114**. The delivery data obtaining unit **113** transmits, via the inter-terminal radio communication unit **116**, the obtained piece of divided delivery data to a client terminal apparatus to which a link has been established (step **S4005**).

When the transmission of the piece of transmittable divided delivery data is completed ("YES" instep **S4006**), the delivery data obtaining unit **113** searches for a neighboring terminal apparatus **110** with which communication can be established (step **S4007**). The user of each terminal apparatus **110** may move to another position, and hence various terminal apparatuses **110** could be a neighboring terminal apparatus **110** with which the terminal apparatus **110** can communicate. Accordingly, in step **54007**, the delivery data obtaining unit **113** again receives a beacon signal transmitted from a neighboring terminal apparatus **110** so as to specify the neighboring terminal apparatus **110** again. Then, the delivery data obtaining unit **113** returns to the process of step **S4002**.

When it is determined that a piece of transmittable divided delivery data is not stored in the delivery data storage unit **114** ("NO" in step **S4004**), the delivery data obtaining unit **113** transmits a disconnection request for the link to the client terminal apparatus to which a link has been established. The delivery data obtaining unit **113** determines whether all of the pieces of divided delivery data have completely been received (step **S4008**). Specifically, the delivery data obtaining unit **113** checks whether every block of the data map information recorded in the data map information database **113**B has been flagged to indicate that the terminal apparatus **110** has received a piece of divided delivery data corresponding to the block. When, for example, the terminal apparatus **110** that performs the server process series is a representative server terminal apparatus, every block of data map information is flagged to indicate that the terminal apparatus **110** has received a piece of divided delivery data corresponding to the block.

When it is determined that all of the pieces of divided delivery data have been received ("YES" instep **S4008**), the terminal apparatus **110** ends the processing sequence for obtaining delivery data started in step **S3001** (step **S4009**). When it is determined that some pieces of divided delivery data have not been received ("NO" in step **S4008**), the terminal apparatus **110**, i.e., a terminal apparatus **110** that has served as a server terminal apparatus to perform the server processing sequence, shifts to a client process (step **S4010**).

With reference to FIG. **15**, the following will describe an exemplary client process performed by a terminal apparatus **110** in accordance with an embodiment.

When a terminal apparatus **110** serves as a client terminal apparatus to start a client processing sequence (step **S5001**), the delivery data obtaining unit **113** of the terminal apparatus **110** waits for access from a neighboring terminal apparatus **110** operated as a server terminal apparatus (step **S5002**).

The delivery data obtaining unit **113** receives a broadcast signal transmitted from the server terminal apparatus via the inter-terminal radio communication unit **116**, and, in accordance with the received broadcast signal, establishes a link to

the server terminal apparatus via the inter-terminal radio communication unit **116** (step S**5003**). The delivery data obtaining unit **113** refers to the flag of each block within the data map information recorded in the data map information database **113**B so as to identify a piece of divided delivery data that has not been received. The delivery data obtaining unit **113** transmits, via the inter-terminal radio communication unit **116**, information on the piece of divided delivery data that has not been received to the server terminal apparatus to which a link has been established (step S**5004**). The information on the piece of divided delivery data that has not been received may be a unique address assigned to the piece of divided delivery data, or may be the block number the piece of divided delivery data.

When the piece of divided delivery data that has not been received is not stored in the server terminal apparatus to which a link has been established ("NO" in step S**5005**), the delivery data obtaining unit **113** receives a link disconnection request transmitted from the server terminal apparatus to which a link has been established (step S**5006**). The delivery data obtaining unit **113** causes the inter-terminal radio communication unit **116** to disconnect the established link to the server terminal apparatus (step S**5007**) and returns to the process of step S**5002**.

When the piece of divided delivery data that has not been received is stored in the server terminal apparatus to which a link has been established ("YES" in step S**5005**), the delivery data obtaining unit **113** receives, from the server terminal apparatus to which a link has been established and via the inter-terminal radio communication unit **116**, the piece of divided delivery data that has not been received (step S**5008**).

When the receiving of the piece of divided delivery data that has not been received is completed ("YES" in step S**5009**), the delivery data obtaining unit **113** stores the piece of received divided delivery data in the delivery data storage unit **114** (step S**5010**). The delivery data obtaining unit **113** also updates the data map information recorded in the data map information database **113**B (step S**5011**). Specifically, the delivery data obtaining unit **113** changes the flag of a block corresponding to the piece of received divided delivery data in such a manner as to indicate that the terminal apparatus **110** has received the piece of divided delivery data. The delivery data obtaining unit **113** shifts to the server process to check whether a piece of divided delivery data transmittable to a neighboring terminal apparatus **110** is present (step S**5012**). As described above, when a piece of divided delivery data transmittable to a neighboring terminal apparatus **110** is not present ("NO" in step S**4004**) and the terminal apparatus **110** has received all of the pieces of divided delivery data ("YES" in step S**4008**), the terminal apparatus **110**, which has shifted to the server process, ends the processing sequence for obtaining delivery data started in step S**3001** (step S**4009**).

As can be appreciated from the descriptions above, in the radio access system. **1** in accordance with an embodiment, the congestion suppressing apparatus **60** controls data delivery in a manner such that the cloud server **20** delivers delivery data **11**A to a representative server terminal apparatus within a terminal apparatus group. The radio access system **1** in accordance with an embodiment is configured in a manner such that delivery data **11**A is delivered from a representative server terminal apparatus that has received delivery data **11**A to each terminal apparatus **110** through communications between the terminal apparatuses **110** within a terminal apparatus group.

Therefore, according to a radio access system in accordance with an embodiment, the minimal necessary bandwidth to deliver data to a representative server terminal apparatus may be a sufficient bandwidth needed for the radio-access-network side, including abase station apparatus, to deliver data to terminal apparatuses **110** geographically concentrated in a particular area. A radio access system in accordance with an embodiment may prevent requests to enable communications with a plurality of geographically concentrated terminal apparatuses from being concentrated on a particular communications infrastructure within a radio access network, thereby preventing congestion in the particular communications infrastructure.

Mere examples of radio access systems in accordance with embodiments have been described, and it should be noted that various changes can be made to the radio access systems described above.

For example, the congestion suppressing apparatus **60** may be connected to the core network **50** without the intervention of the Internet network **40**. The congestion suppressing apparatus **60** may be integrated with another element within the radio access network, e.g., the cloud server **20** or the position information managing apparatus **30**.

The processes above performed by elements of the congestion suppressing apparatus **60** may be managed in a software-based instruction format such as a congestion suppression program, and the congestion suppression program may cause a computer to perform various processes. In one possible example, the congestion suppression program is recorded in a recording medium and is stored in the storage **60**A-**3** via the storage medium drive **60**A-**4**. The CPU **60**A-**1** loads the stored congestion suppression program into the memory **60**A-**2** and executes this program.

In addition, the processes above performed by elements of the terminal apparatus **110** may be managed in a software-based instruction format such as a delivery-data obtainment program, and the delivery-data obtainment program may cause a computer to perform various processes. In one possible example, the delivery-data obtainment program is recorded in a recording medium and is stored in the storage **110**A-**3** via the storage medium drive **110**A-**4**. The CPU **110**A-**1** loads the delivery-data obtainment program into the memory **110**A-**2** and executes this program.

The aforementioned advantages may be obtained even when the changes described above are made to the radio access system in accordance with any of the embodiments.

All examples and conditional language provided herein are intended for pedagogical purposes of aiding the reader in understanding the invention and the concepts contributed by the inventor to further the art, and are not to be construed as limitations to such specifically recited examples and conditions, nor does the organization of such examples in the specification relate to a showing of the superiority and inferiority of the invention. Although one or more embodiments of the present invention have been described in detail, it should be understood that various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

What is claimed is:

1. A radio access system comprising:

a controlling apparatus configured to

receive position information transmitted from terminal apparatuses,

store the received position information,

obtain, from among the stored position information, position information of destination terminal apparatuses to which delivery data is to be delivered,

when the destination terminal apparatuses are judged to be concentrated in a particular area in accordance with the obtained position information, group the des-

tination terminal apparatuses present in the particular area together as a terminal apparatus group,

select a representative server terminal apparatus from the terminal apparatuses included in the terminal apparatus group,

transmit group information related to the terminal apparatuses included in the terminal apparatus group to each of the terminal apparatuses included in the terminal apparatus group,

divide the delivery data into a plurality of pieces of divided delivery data in accordance with a number of the terminal apparatuses included in the terminal apparatus group and a data size of the delivery data,

create data map information indicating a delivery rule for delivering the delivery data from the representative server terminal apparatus to another terminal apparatus within the terminal apparatus group by assigning an address to each of the plurality of pieces of divided delivery data,

add information for identification of the representative server terminal apparatus to the created data map information, and transmit the data map information to each of the terminal apparatuses included in the terminal apparatus group, and

instruct a delivery data server to deliver the delivery data to the representative server terminal apparatus; and

a terminal apparatus configured to

transmit the position information of the terminal apparatus to the controlling apparatus,

receive the group information and data map information transmitted from the controlling apparatus, and

obtain the delivery data that the representative server terminal apparatus has obtained from the delivery data server, by communicating, in accordance with the received data map information, with the another terminal apparatus within the terminal apparatus group included in the received group information, wherein

the terminal apparatus transmits, to the another terminal apparatus within the terminal apparatus group, the address of a piece of divided delivery data that has not been obtained from among the plurality of pieces of divided delivery data, and obtains the delivery data by receiving the piece of transmitted divided delivery data corresponding to the address from the another terminal apparatus.

2. The radio access system according to claim **1**, wherein

using a number of the delivery destination terminal apparatuses present in the particular area, a processing capacity of a base station apparatus that covers communications of the delivery destination terminal apparatuses present in the particular area, and a requested delivery rate of the delivery data, the controlling apparatus selects a number of the terminal apparatus groups and selects terminal apparatuses to be included in each of the terminal apparatus groups.

3. The radio access system according to claim **1**, wherein

the controlling apparatus uses model information of each of the terminal apparatuses included in the terminal apparatus group so as to select, from the terminal apparatuses included in the terminal apparatus group, a terminal apparatus of a model for a high-speed communication as the representative server terminal apparatus.

4. The radio access system according to claim **1**, wherein

the controlling apparatus uses power information of each of the terminal apparatuses included in the terminal apparatus group so as to select, from the terminal apparatuses included in the terminal apparatus group, a terminal apparatus whose battery is not easily drained as the representative server terminal apparatus.

5. The radio access system according to claim **1**, wherein

the controlling apparatus samples position information of each of the terminal apparatuses included in the terminal apparatus group at certain time intervals, and selects a terminal apparatus that moves a short distance from the terminal apparatuses included in the terminal apparatus group as the representative server terminal apparatus.

6. The radio access according to claim **1**, wherein

the controlling apparatus selects a number of the representative server terminal apparatuses for the terminal apparatus group in accordance with a scale of the terminal apparatus group and a requested delivery rate of the delivery data.

7. The radio access system according to claim **1**, wherein

the controlling apparatus obtains a bandwidth use situation of a base station apparatus that covers a communication area of the destination terminal apparatuses present in the particular area, and selects a number of representative server terminal apparatuses for the terminal apparatus group in accordance with the obtained bandwidth use situation and a scale of the terminal apparatus group.

8. A controlling apparatus comprising:

a position information managing unit configured to receive and store position information transmitted from a terminal apparatus;

a grouping unit configured to

obtain, from the position information managing unit, position information of destination terminal apparatuses to which delivery data is to be delivered,

when the destination terminal apparatuses are judged to be concentrated in a particular area in accordance with the obtained position information, group the destination terminal apparatuses present in the particular area together as a terminal apparatus group,

select a representative server terminal apparatus from the terminal apparatuses included in the terminal apparatus group, and

transmit group information related to the terminal apparatuses included in the terminal apparatus group to each of the terminal apparatuses included in the terminal apparatus group; and

a data mapping unit configured to

divide the delivery data into a plurality of pieces of divided delivery data in accordance with a number of the terminal apparatuses included in the terminal apparatus group and a data size of the delivery data,

create data map information indicating a delivery rule for delivering the delivery data from the representative server terminal apparatus to another terminal apparatus within the terminal apparatus group by assigning an address to each of the plurality of pieces of divided delivery data,

add information for identification of the representative server terminal apparatus to the created data map information, and transmit the data map information to each of the terminal apparatuses included in the terminal apparatus group, and

instruct a delivery data server to deliver the delivery data to the representative server terminal apparatus.

9. A terminal apparatus comprising:

a terminal information transmitting unit configured to transmit position information of the terminal apparatus to a controlling apparatus;

a delivery information receiving unit configured to

when destination terminal apparatuses to which delivery data is to be delivered are judged to be concentrated in a particular area in accordance with the transmitted position information and position information of another terminal apparatus, receive, from the controlling apparatus, group information related to a plurality of terminal apparatuses included in a terminal apparatus group to which the destination terminal apparatuses present in the particular area belong, and

receive data map information to which information for identification of a representative server terminal apparatus selected from the plurality of terminal apparatuses included in the terminal apparatus group has been added, the data map information indicating a delivery rule for delivering the delivery data from the representative server terminal apparatus to another terminal apparatus within the terminal apparatus group, the data map information being created by assigning an address to each of a plurality of pieces of divided delivery data which is obtained by dividing the delivery data in accordance with a number of the terminal apparatuses included in the terminal apparatus group and a data size of the delivery data; and

a delivery data obtaining unit configured to

obtain the delivery data that the representative server terminal apparatus has obtained from the delivery data server, by communicating, in accordance with the data map information received by the delivery information receiving unit, with the another terminal apparatus within the terminal apparatus group included in the group information received by the delivery information receiving unit, wherein

the delivery data obtaining unit transmits, to the another terminal apparatus within the terminal apparatus group, the address of a piece of divided delivery data that has not been obtained from among the plurality of pieces of divided delivery data, and obtains the delivery data by receiving the piece of transmitted divided delivery data corresponding to the address from the another terminal apparatus.

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